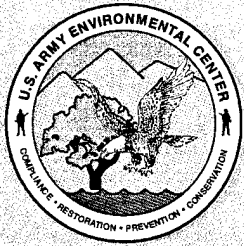
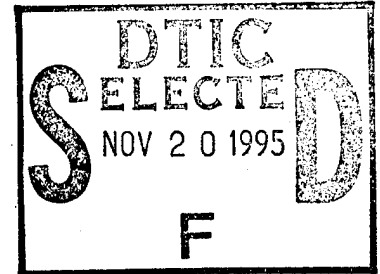


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**U.S. Army
Environmental
Center**

Report No. SFIM-AEC-ET-CR-95078
FINAL REPORT



Health and Safety Plan for Pilot-Scale Demonstration of Red Water Treatment by Wet Air Oxidation and Circulating Bed Combustion

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October 1995
Contract No. DACA31-91-D-0074
Task Order No. 0005

Prepared by:

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Cincinnati, OH 45246

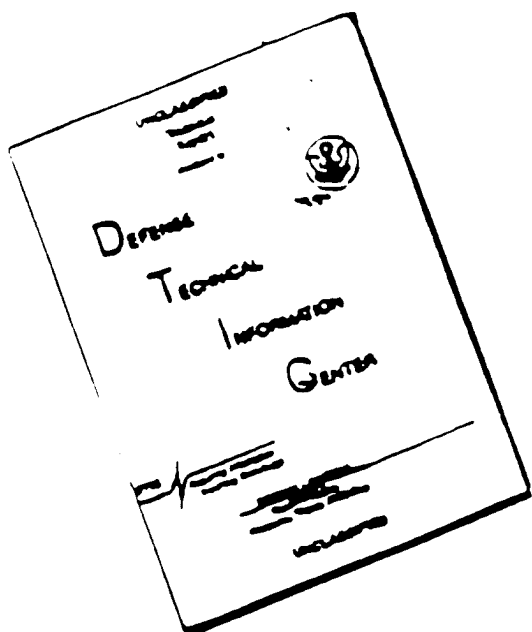
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Prepared for:

U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010-5401

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HEALTH AND SAFETY PLAN

FOR

**PILOT SCALE DEMONSTRATION OF
TREATMENT OF RED WATER BY WET AIR OXIDATION
AND CIRCULATING BED COMBUSTION**

USAEC Contract No. DACA 31-91-D-0074
Task Order No. 5

Prepared by

IT Corporation
Cincinnati, Ohio

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Preface

As part of the U.S. Army's ongoing program related to the research and development of red water treatment technologies, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot-scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives included initial development of a Test Plan and Health and Safety Plan for these demonstrations. The Health and Safety Plan presented in this document is intended to serve as a guide for the development of a complete Health and Safety Plan when the next phase of this program is implemented.

Red water is not currently generated by the U.S. Army or any other part of the U.S. Department of Defense nor has it been generated in the recent past. An accurate and complete database does not exist in regard to the chemical and physical nature of red water. Therefore, it was not possible to complete an accurate analysis of the associated chemical and physical hazards. Additionally, the source of red water for testing and the location where the tests will be conducted (i.e., the host facility) have not been identified. Therefore, waste and site-specific concerns and requirements can not be accurately or completely addressed at this time. Similarly, because this phase of the investigation included completion of conceptual designs only, the assessment of equipment-specific hazards is preliminary in nature.

For the reasons presented above, this Health and Safety Plan does not, and is not intended to, represent a completed document that is ready for implementation. Out of necessity, this plan is often generic in nature or based on stated assumptions. In the future, when the host facility has been selected and when red water is available for pilot-scale testing, this plan will be available for review, revision, and expansion to reflect specific conditions and requirements associated with the host site, the actual equipment, and the specific waste. Because of the unique and largely undocumented nature of red water, once a source has been identified a critical initial objective will be characterization of its physical and chemical nature and the associated hazards.

Reviews and Approvals

Project Manager
USAEC Research and Development Contractor

Date

Health and Safety Officer
USAEC Research and Development Contractor

Date

Health and Safety Officer
US Army Environmental Center

Date

Project Manager
Host Facility

Date

Health and Safety Officer
Host Facility

Date

I have read, understand and agree to abide by the provisions as detailed in this Site-Specific Health and Safety Plan. Failure to comply with these provisions may lead to disciplinary action and/or my dismissal from the work site.

[illegible]

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EMERGENCY RESPONSE NUMBERS

[site specific information to be inserted]

Title	Name	Phone Number
Host Facility Emergency/Security		
Host Facility		
Project Manager		
Project Engineer		
Hazards Analysis Manager		
Health and Safety Manager		
USAEC Task Order Contractor		
Project Manager		
Health and Safety Manager		
Regional Manager		
USAEC		
COTR		
Project Engineer		
Safety Manager		

1.0 Introduction

The production of trinitrotoluene (TNT), the major component of most of the Department of Defense's explosives, generates a wastewater stream called red water. Because of its reactivity, red water has been listed as a hazardous waste (K047) by the U.S. Environmental Protection Agency (U.S. EPA) under Subtitle C, Part 265 of the Resource Conservation and Recovery Act (RCRA). Four Army Ammunition Plants (AAPs) -- Radford, Joliet, Newport and Volunteer -- are equipped with production facilities necessary for the manufacture of TNT. However, the TNT production facilities at these AAPs are currently idle and in mothballed status. None of these facilities has produced TNT during recent years because the military's peace-time requirement is too small to justify the high cost of operation. Additionally, none of the AAPs currently has the capability to treat or dispose of red water.

Demonstration of an acceptable waste treatment technology is an important aspect in increasing the readiness of these facilities to mobilize TNT production capability. It is anticipated that at a future time, the U.S. Army Environmental Center (USAEC) will conduct a demonstration to evaluate potential methods for treating red water. Previously, a comparative evaluation of 30 potential technologies for the treatment of red water was completed by the USAEC. Two technologies -- circulating bed combustion (CBC) and wet air oxidation (WAO) -- were concluded to have the potential for successfully treating red water and were sufficiently advanced to warrant pilot-scale testing. These technologies are the subject of this Health and Safety (H&S) Plan.

Because red water is not currently available for testing and because a host facility has not been selected, the first phase of the demonstration is the preparation of conceptual designs and plans. This Health and Safety Plan is intended to serve as a starting point for the next phase of activities. For the purposes of this document, it is assumed that the USAEC will contract a Task Order Contractor (TOC) to conduct the demonstrations. Further, it is assumed that the TOC will issue two subcontracts for the preparation of final designs and fabrication of pilot-scale WAO and CBC units. The assumed general roles and responsibilities of the TOC, its two subcontractors, and the host facility are indicated below:

Task Order Contractor

- Review technologies and recommend selection
- Oversee Final Design preparation

- Define installation support requirements
- Conduct regulatory review
- Assist host facility in revising/obtaining permits
- Prepare Final Design Report
- Procure pilot-scale WAO and CBC units
- Complete and finalize Test Plans and Safety Plans
- Prepare a Site Safety Submission
- Provide on-site coordination and oversight during installation and testing
- Perform industrial hygiene sampling and analysis for chemical and physical hazards
- Perform sampling and analysis to document performance
- Provide photographic documentation
- Prepare a technical project report.

Subcontractor for WAO

- Prepare final design of pilot-scale WAO equipment
- Provide input on Test Plan, Safety Plan, and Site Safety Submission
- Fabricate, ship, install, and operate test equipment for WAO treatment
- Provide input on technical reports.

Subcontractor for CBC

- Prepare final design of pilot-scale CBC equipment
- Provide input on Test Plan, Safety Plan, and Site Safety Submission
- Fabricate, ship, install, and operate test equipment for CBC treatment
- Provide input on technical reports.

Host Facility

- Review and comment on Test Plan and Safety Plan
- Review equipment selection and design
- Conduct hazards review
- Prepare, with TOC input, standard operating procedures
- Provide photographic documentation
- Provide facilities support including utilities and operators
- Provide on-site analytical support
- Review and comment on the technical reports.

These roles have been assumed and defined to ensure that the Health and Safety Plan sufficiently addresses the anticipated complexity of the project organization. Specific health and safety roles of the USAEC, the TOC, subcontractors, and host facility are discussed in Section 2 of this document.

1.1 Objective

The objective of this Health and Safety (H&S) Plan is to address general health and safety issues related to the red water treatment demonstrations and to address health and safety issues specific to each of the two treatment technologies. Because the pilot test location (i.e., host facility) has not been determined, this H&S Plan is not site-specific. During the next phase of activities, the H&S Plan must be revised based on waste and site-specific information and changes in field conditions. The Safety Plan must be prepared in accordance with the requirements of DD Form 1423, Sequence A003.

Additionally, a Site Plan Safety Submission will likely be required as a separate document if the demonstration(s) are conducted at an AAP. The Site Plan Safety Submission will emphasize the safety aspects of the specific site requirements and process equipment.

1.2 Facility and Location Description

This section should include a concise description of the specific location(s) where the pilot-scale demonstrations will be conducted. As a minimum, the following information should be included:

- Facility name and location
- Specific location at the facility (e.g., building number)
- Map of the general facility showing the specific test site
- Current use and operational status of the building/site; in particular, any operations other than the red water demonstration that will occur in the building should be identified
- Schematic diagram of the specific test location.

1.3 Policy Statement

The USAEC and/or the TOC should provide a written policy statement regarding safety. An example of that statement is presented below.

A safe and healthful work environment will be provided for all employees and contractors. No phase of operations or administration is considered to be of greater importance than injury and illness prevention. Safety takes precedence over expediency or shortcuts. Every accident and every injury is believed to be avoidable, and every reasonable step will be taken to reduce the possibility of injury, illness, or accident.

This H&S Plan describes the procedures that must be followed by all project personnel while working on the site. Operational changes which could affect the health or safety of personnel, the community, or the environment will not be made without prior approval of the host facility's safety department, the USAEC's Safety Branch, the TOC, the TOC's H&S Department, and the subcontractor engineers.

The provisions of this H&S Plan are mandatory to all on personnel assigned to the project. All visitors to any of the work sites are required to read and sign this H&S Plan and to abide by these procedures. Work conditions can change as operations progress. The host facility's safety department and the TOC's H&S Manager will provide written addenda to this H&S Plan when changes warrant. No changes to the H&S Plan will be implemented without prior approval of the host facility's safety department, the TOC's H&S Manager, the USAEC's Safety Branch, and the subcontractors' authorized representatives.

1.4 References

The final H&S Plan must comply with, applicable Occupational Safety and Health Administration (OSHA), U.S. EPA, and appropriate state/local regulations. This H&S Plan was prepared in consideration of the guidelines established in the following documents:

- Standard Operating Safety Guides (U.S. EPA November 1984)
- 29 Code of Federal Regulations (CFR) 1926, Construction Industry, Occupational Safety and Health Administration (OSHA) Safety and Health Standards
- 29 CFR 1910, General Industry OSHA Safety and Health Standards
- 29 CFR 1910.120, OSHA Final Rule dated March 6, 1989, "Hazardous Waste Operations and Emergency Response"
- National Institute of Occupational Safety and Health (NIOSH)/OSHA/USCG/U.S. Environmental Protection Agency (EPA), "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985
- American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values and Biological Exposure Indices," 1989-1990, or most current version
- U.S. Army Corps of Engineers, Safety and Health Requirements Manual, EM 385-1-1, October, 1992

- U.S. Department of Health and Human Services (DHHS), "NIOSH Sampling and Analytical Methods," DHHS (NIOSH) Publication 84-100
- American National Standards Institute (ANSI), Practice for Respiratory Protection, Z88.2, 1980
- ANSI, Emergency Eyewash and Shower Equipment, Z41.1, 1983
- ANSI, Protective Footwear, Z358.1, 1981
- ANSI Physical Qualifications for Respirator Use, Z88.6, 1984
- ANSI, Practice for Occupational and Educational Eye and Face Protection, Z87.1, 1968.

The contents of the final H&S Plan must be consistent with H&S policies and procedures of the USAEC, the TOC, and the host facility. In addition, the subcontractors' safety departments should review this H&S Plan to ensure that it is consistent with their recommended safety rules and regulations.

2.0 Responsibilities

An example organization of responsibility for implementation of a H&S Plan is illustrated in Figure 2-1. The USAEC, TOC, and host facility are responsible for the safe performance of their personnel and are accountable for adherence to all applicable H&S procedures and requirements specified herein. It is anticipated that the planned demonstrations will involve at least one host facility, a USAEC TOC, and two major equipment subcontractors. Further, it is anticipated that the pilot-scale tests will require at least two host facility operator's, the TOC's Project Engineer, and the Project Engineer from the WAO or CBC subcontractor (depending on the specific technology being tested). Because of the multiple parties involved and the fact that the demonstrations will involve testing a reactive waste under conditions of high temperature and/or pressure, careful coordination of all activities and responsibilities will be essential. If, as assumed, the demonstration is conducted at an Army facility (e.g., AAP), numerous health, safety, and hazards prerequisites will be in place. The demonstration will have to be conducted in compliance with all host facility requirements.

A potential complicating factor is the contractual relationships of the parties involved. If direct contractual control does not exist, for example if the USAEC contracts separately with the TOC and the host facility, it will be imperative that each of these parties clearly understand the roles and responsibilities of the other(s). To facilitate this understanding, meetings/discussions related to health and safety must be initiated early in the project and conducted frequently during the duration of the project.

2.1 All Personnel

Each person, once properly trained and authorized, is responsible for his/her own health and safety, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to his/her Supervisor and/or the Site Supervisor. All personnel are responsible for continuous adherence to these health and safety procedures during the performance of their work. No person may work in a manner that conflicts with the intent of, or the inherent safety and environmental precautions expressed in these procedures. After due warnings, any person who violates safety procedures will be dismissed from the site. All on-site personnel must be trained in accordance with 29 CFR 1910.120 and this document.

The TOC Project Manager shall maintain on-site documentation of all training and medical surveillance outlined in 29 CFR 1910.120 and 29 CFR 1910.134. The USAEC and host facility will maintain the same documentation for their employees.

2.2 Host Facility

For the purpose of this H&S Plan, it is assumed that the facilities support at the host facility (e.g., an AAP) will be contracted directly by the USAEC. For example, during the ongoing demonstration of DNT wastewater treatment at the Radford AAP, the USAEC contracted with Hercules, Inc., the facility GO-CO operator, for facilities support including equipment operators. An alternate arrangement would involve subcontracting the host facility by the USAEC TOC. In this case, the TOC subcontractor requirements outlined below would apply and the TOC would have responsibility for the facility.

2.2.1 Director of Safety

Because the physical work will be conducted by staff from the host facility, the facility's Director of Safety is ultimately responsible for ensuring that all project activities are completed in accordance with requirements set forth in this H&S Plan and applicable site-specific safety protocols. The host facility's Director of Safety will review the technology and equipment selection with respect to consistency with site safety requirements. A hazards analysis will be conducted for each test unit based on a review of equipment drawings and specifications. To facilitate acceptance of the equipment, the safety and hazards staff at the host facility should be involved in all phases of equipment selection, design, and fabrication. The hazards analysis will result in a written document that indicates whether the equipment is acceptable as designed and, if not, what modifications are required. Successful completion of the safety and hazards review will likely be required before the host facility will accept shipment of the equipment.

2.3 The USAEC Task Order Contractor (TOC)

2.3.1 Health and Safety Manager

The TOC's H&S Manager is responsible for developing and coordinating the site-specific H&S Plan and addenda as required and as applicable for TOC employees. This H&S Plan includes medical surveillance and training requirements, hazard assessment, personal protective equipment (PPE) specifications, field implementation procedures, and audits. The H&S Manager will, in consultation with the Director of Safety from the host facility and from TOC equipment subcontractors, issue written addenda to the H&S Plan if warranted by changed conditions. The

H&S Manager and his staff report to the TOC's Project Manager for operational matters. The H&S Manager is the TOC's contact for regulatory agencies on matters of safety and health. Other H&S Manager responsibilities include:

- General H&S program administration
- Developing, with the host facility's Director of Safety, site-specific employee/community emergency response plans, as required, based on expected hazards
- Determining the level of personnel protection required
- Updating equipment or procedures based on information obtained during site operations
- Establishing air monitoring parameters based on expected contaminants
- Establishing employee exposure monitoring notification programs
- Ensuring that all TOC site personnel have been given the proper medical clearance, ensuring that all site personnel have met appropriate training requirements and have the appropriate training documentation on site, and monitoring all team members to ensure compliance with the H&S Plan.

2.3.2 On-Site Health and Safety Representative

The TOC's On-site H&S Representative will report to the TOC's H&S Manager and will conduct the routine duties for H&S coordination with the assistance of the TOC's Project Engineer. Specifically, the On-site H&S Representative will administer the site-specific H&S Plan and addenda; this will include communicating site requirements to all on-site project personnel (including any subcontractor personnel) and consultation with the TOC's H&S Manager. The On-Site H&S Representative will be responsible for informing the Health and Safety Manager and the Project Manager of any changes in the Work Plan so that those changes may be properly addressed. Other responsibilities include:

- Enforcing the requirements of the H&S Plan. This includes performing daily safety inspections of the work site
- Stopping work, as required, to ensure personal safety and protection of property, or where life or property-threatening noncompliance with safety requirements is found
- Observing on-site project personnel for signs of chemical or physical trauma

- Investigating significant accidents and illnesses and implementing corrective action plans
- Determining and posting routes to capable medical facilities and emergency telephone numbers (including poison control facilities) and arranging emergency transportation to medical facilities
- Notifying local emergency officers of the nature of the site operations, and posting of their telephone numbers in an appropriate location
- Implementing air monitoring parameters based on expected contaminants
- Implementing employee exposure monitoring notification programs.

The On-site H&S Representative will be responsible for ensuring that any accident or incident on the project is reported and thoroughly investigated according to site-specific safety protocols. He is also responsible for reporting all accidents and incidents to USAEC according to the criteria in Section 11.5.3 of this H&S Plan. Lastly, he must approve any addenda or modifications of the H&S Plan in writing.

2.3.3 Project Engineer

The TOC's Project Engineer will support the on-site H&S Representative and will be assist with the field implementation of the H&S Plan by TOC employees.

2.4 Subcontractors

2.4.1 Director of Safety

The Directors of Safety from the TOC's equipment subcontractors are responsible for supplying necessary information to the host facility's Director of Safety and the TOC's H&S Manager for the Hazards Analysis and development of the Final H&S Plan. In addition, the Directors of Safety from the TOC's equipment subcontractors will perform at least one on-site safety review during the project. Lastly, they must approve any addenda or modifications of the H&S Plan that pertain to their equipment in writing.

2.4.2 Project Engineer

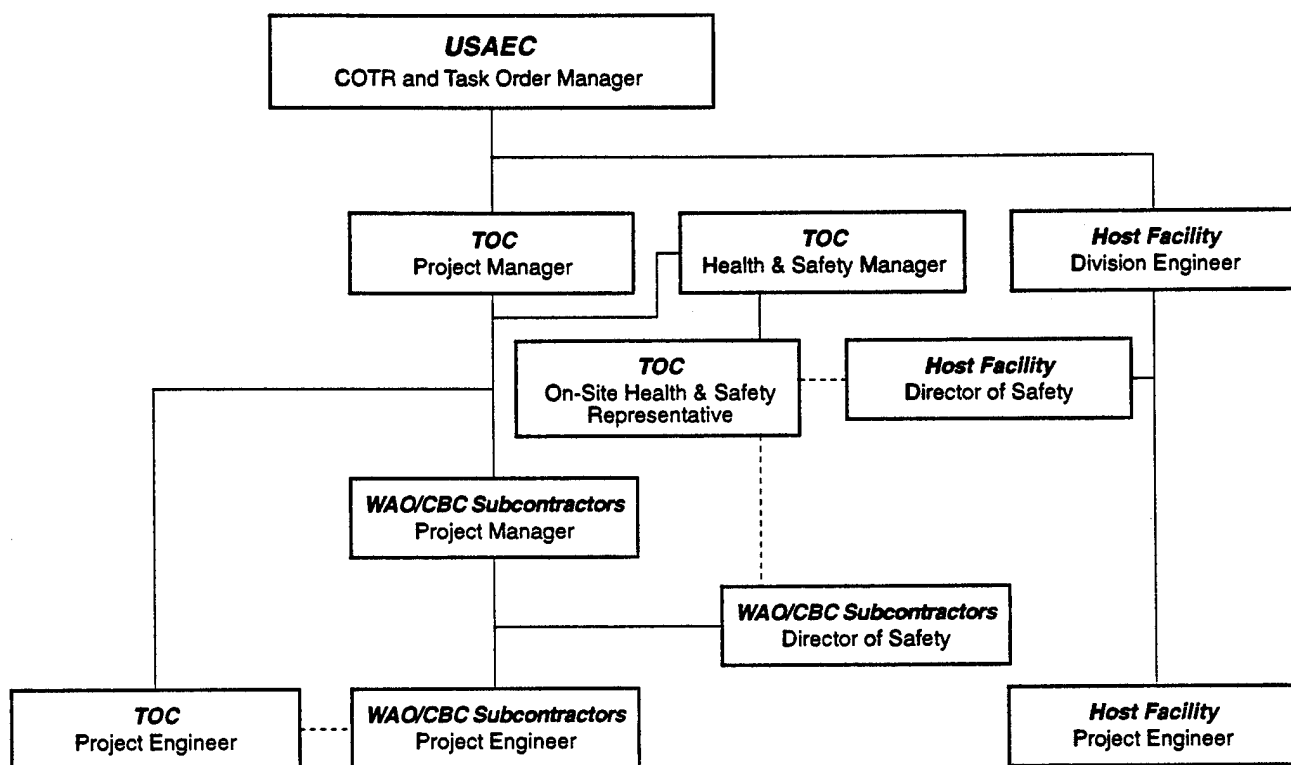
The Project Engineers will assume the routine duties for H&S coordination of their personnel with the assistance of the Director of Safety of the two subcontractors. The Project Engineers will administer the site-specific H&S Plan and addenda. Other responsibilities include:

- Investigating significant accidents and illnesses and implementing corrective action plans
- Determining and posting routes to capable medical facilities and emergency telephone numbers (including poison control facilities) and arranging emergency transportation to medical facilities
- Notifying local emergency officers of the nature of the site operations, and posting of their telephone numbers in an appropriate location
- Performing regular site inspections
- Implementing air monitoring parameters based on expected contaminants
- Implementing employee exposure monitoring notification programs.

2.5 On-Site Personnel and Visitors

All on-site personnel (contractor and subcontractor), including visitors, are required to read and acknowledge their understanding of this H&S Plan and other applicable host facility specific protocols. All site project personnel are expected to abide by the requirements of the H&S Plan and cooperate with site supervision in ensuring a safe and healthful work site. Site personnel -- including contractors and subcontractors -- are required to immediately report any of the following to the Safety Director of the host facility and the TOC's Health and Safety Manager:

- Accidents and injuries, no matter how minor
- Unexpected or uncontrolled release of chemical substances
- Any symptoms of chemical exposure
- Any unsafe or malfunctioning equipment
- Any changes in site conditions which may affect the H&S of project personnel.



Legend

USAEC U.S. Army Environmental Center
 COTR Contracting Officer's Technical Representative
 TOC Task Order Contractor
 WAO Wet Air Oxidation
 CBC Circulation Bed Combustion

Figure 2-1.
Project Organization.

3.0 Job Hazard Analysis

The job hazard analysis in this section was developed with the information available at the time this H&S Plan was written. As specific hazards become known after a source of red water is identified, a host facility is selected, and specific equipment is designed, a revised and complete H&S Plan must be developed.

3.1 Scope of Work

This H&S Plan includes activities related to the installation and operation of WAO and CBC pilot-scale treatment plants. Project activities addressed include those involved with equipment installation, material handling, sample collection and physical/chemical hazards involved with pilot-plant operation. It is assumed that the pilot-scale equipment will be installed and operated at a host facility over a period of a few weeks or months. After testing, the equipment will be decontaminated and returned to the vendor (if rented or leased) or shipped to another Army facility for other use or storage.

3.2 Waste Stream Characteristics

3.2.1 Red Water

Red water is the aqueous effluent generated during sellite purification of crude TNT. Red water has a deep red, or sometimes black color, and is a complex mixture. It is anticipated that the characteristics and composition of red water will vary with changes in feed stocks, operating conditions, and handling/storage; however, the degree of variability is as yet unknown. Depending on the TNT production process and the degree of water recycle used, red water generally contains from 15 to over 30 percent solids, has a pH in the range of 7.0 to 9.7, and specific gravity of approximately 1.1. Roughly half of the solids are inorganic salts; the remainder are nitro bodies including mainly sodium sulfonates of trinitrotoluene and an alpha-TNT-sellite complex. TNT is present in only trace amounts. Other organic constituents include complex, unidentified dye bodies formed from the photolysis of alpha-TNT by sunlight. The heavy metals present in the red water are thought to be a result of acid leaching from the stainless steel reaction vessels and holding tanks (Hercules, 1973).

Red water is a RCRA listed hazardous waste (K047), and is classified as such due to the reactivity of the wastewater. If the solids in the red water are allowed to settle and accumulate, an explosive reaction could occur if initiated by impact, friction, heat or electrostatic discharge (Hercules, 1991). A material safety data sheet (MSDS) does not exist for red water.

The database documenting the chemical, physical, and toxicological characteristics of red water is extremely limited. This is primarily due to the fact that red water has not been generated at Army facilities for a number of years. During the time of generation, the need for detailed characterization did not exist; therefore, an analytical database was not compiled. In addition, during this time, analytical methodology associated with quantitation of the unique compounds present was not well advanced. These factors result in the limited database that exists today. Upon identification and acquisition of a source of red water for testing, a thorough characterization must be conducted to identify hazards. This may involve development or modification of analytical techniques for quantitation of unique compounds in a unique matrix.

Tables 3-1 and 3-2 present the available characteristics of red water. Based on discussions held with representatives of RAAP and ICI Explosives Canada, it is believed that composition of TNT red water can vary significantly (IT Corporation, 1993a and 1993b). This is apparently due to the fact that MIL SPEC grade TNT can be produced by a wide range of process and operating parameters. However, significant data on the variability of red water is not available at this time. Where available, a range of data is presented.

At this time, it is anticipated that bulk storage, at the test location, of approximately 50,000 gallons of red water will be required. Specific hazards and safety protocols associated with this bulk storage must be assessed based upon the characteristics of the actual red water. Obvious concerns involve secondary containment; control of venting and off gases; temperature and pressure controls; and mixing, control, and handling of solids or precipitates. Specific details and protocols can be defined when the red water has been adequately characterized and when the host facility is determined.

3.2.2 WAO Byproducts and Residuals

The byproducts from the WAO treatment process are anticipated to be a non-reactive liquid effluent and gaseous emissions. Because of the largely unknown nature of the influent red water, lack of existing data on WAO byproducts from treatment of red water, and lack of sufficient analytical techniques, the exact nature of the WAO byproducts is not known at this time. In

general, however, the effluent is anticipated to have a low pH due to the oxidation of sulfur compounds and decomposition of ammonia (Zimpro, 1992). Previous tests have indicated an increase in total metals concentrations; however, the increase was attributed to leaching from the reactor vessel. In addition, the following compounds and classes of compounds may be present in the treated wastewater:

- Acetic acid
- Dinitrotoluene sulfonates
- Nitrates
- Sulfates
- Phenol
- Nitrated phenols
- Non-oxidized compounds present in the influent.

Analytical results from bench-scale WAO autoclave tests are provided in Table 3-3 (Phull, 1992). While these results do not conclusively define WAO effluent from red water treatment, they provide the available basis for planning future evaluations.

3.2.3 CBC Feed Materials, Byproducts, and Residuals

The expected byproducts from the CBC treatment process are anticipated to be a non-reactive ash and gaseous emission.

The feed materials during routine operations is red water. Red water is the aqueous effluent generated during sellite purification of crude TNT. The anticipated characteristics of red water are presented in Section 3.2.1.

Explosion Potential - Red water is anticipated to have a solids heat content of 3,200 Btu/lb. The solids are in a solution that is 85 percent water, which makes the red water endothermic.

CBCs were originally designed to manage materials with high heat content for energy production. The level of energy in the red water should be within acceptable limits for the CBC. Additionally, the large internal volume of the CBC should dissipate any pressure shocks that could occur from uneven combustion of the red water.

Contaminated Surfaces - Red water will be pumped directly to the CBC feed port. In the unlikely event that red water is spilled, it should be cleaned up using wet methods and not allowed to dry. Dry TNT or related materials can potentially explode due to friction or spark.

The ash from the CBC will be a fine particulate that may be toxic. It is unlikely that explosive materials will be found in the ash to present a physical or chemical hazard. The ash may be toxic due to the presence of metals. The fine particulate will likely be a respiratory hazard.

During testing programs, flammable solvents may be used in the sampling trains and the feed stream may be spiked with materials that are toxic, reactive, flammable, and/or corrosive. MSDS's will be provided by the test team for these substances. It will be incumbent upon the test team to properly store and handle these materials.

3.3 WAO Job Hazard Assessment

This initial job hazard assessment identifies potential safety, health, and environmental hazards associated with the WAO pilot tests and provides for the protection of personnel, the community, and the environment. Because of the complexity and constant change of environmental projects, supervisors must continually inspect the work site to identify hazards which may harm site personnel, the community, or the environment. The TOC Project Engineer must be aware of these changing conditions and discuss them with the TOC's Health & Safety Manager, the host facility's Director of Safety, and the host facility's Project Engineer. The TOC Project Engineer will keep supervisors for any subcontractors informed of the changing conditions. The Health & Safety Manager will prepare addenda (see Appendix A), as necessary, to change the job safety analysis and associated hazard controls.

A hazard analysis of a bench-scale WAO system used for studying red water treatment was conducted by Hercules Inc. for the U.S. Army Construction Engineering Research Laboratory (USACERL) in 1991 (Appendix B). Much of the hazard information provided in the following sections was excerpted from that document. Additional information on hazards associated with the operation of the WAO is presented in the WAO Conceptual Design Report and excerpted in Appendix C.

3.3.1 General Hazard Information

The general hazards associated with treating red water in a WAO system include the following:

- 1) Oxygen incompatibility
- 2) Hot surfaces
- 3) Hot spray
- 4) Thermal explosion
- 5) Contaminated surfaces.

Oxygen Incompatibility - Oxygen incompatibility is a hazard issue only if pure oxygen is used as the oxidizing agent. However, the conceptual design presented in the Project Report includes a WAO system that uses compressed air as the oxidizing agent. The following hazard analysis is included as a contingency to a change to pure oxygen in latter stages of design.

Pure oxygen is a potent oxidizing agent, particularly at elevated pressures and/or temperatures. All elements of the oxygen supply system must be compatible with oxygen use to preclude the possibility of an incident. Within the reactor, the initial oxygen charge may be on the order of several hundred psi, based on previous test conditions. If oxygen is used as the oxidizing agent, the oxygen pressure will about double during reactor heat-up; at the same time the vaporization of water will reduce the oxygen concentration in the ullage of the reactor. The flash point of gasket materials at expected oxygen pressures should be compared to test condition temperatures to determine compatibility.

Hot Surfaces - The reactor will be operated at elevated temperatures (approximately 485°F). Although all equipment with surface temperatures greater than 100°F will be insulated, contact with these surfaces should be avoided, or proper protective equipment should be used if it is necessary to handle components above 100°F. Use of Nomex-type gloves may provide greater dexterity than standard laboratory heat resistant gloves for handling equipment of moderately elevated temperatures.

Hot Spray - The reactor will be operated at elevated temperature and pressure. Any leak in the reactor/piping fittings would result in a spray of hot flashing liquid which could contact and injure any personnel present. The reactor should be leak checked at operating pressure prior to each use because there is a tendency for the joints to loosen when temperature and pressure are frequently increasing and decreasing. Strict adherence to the operating temperature limit shall be followed. Gaskets may soften or melt if temperature limits are exceeded. Use of a face shield is required for any personnel present when the system is pressurized.

Thermal Explosion - Potential hazards in this category relate to an explosive/detonation type reaction of the energetic constituents in the reactor, or thermal runaway oxidation reactions. Raw red water has a reported solids heating value of 3200 BTU/lb (1780 cal/gm) and a solids content of 15 percent. Nitro bodies represent about 55 percent of the solids (8.25 percent of the raw red water).

It is unlikely that raw red water could transit to or propagate a detonation reaction given these levels of nitro bodies. However, the assessment of the potential for such a reaction in diluted red water requires a detailed evaluation of the actual red water.

The heat of combustion of raw red water is anticipated to be on the order of 480 Btu/lb (3200 Btu/lb-solids x 15 percent solids). Instantaneous oxidation of raw red water, if it occurred, would be a hazard as the concomitant temperature/pressure excursion (assuming typical operating conditions of 1000 psia and 484°F) would lead to exceeding the pressure/temperature limits of the reactor. This would cause activation of the reactor rupture disc with release of a flashing, high temperature spray. The likelihood or credibility of a runaway reaction can not be evaluated at this time because of the absence of chemical reaction pathway and kinetic data. Diluting the red water -- as is the case of the system in the Conceptual Design Report -- will reduce the total theoretically available energy input to the system for the same total reactor charge. In the system in the Conceptual Design Report, the initial raw waste stream will be diluted with a high recycle effluent stream (in excess of 20:1) prior to entering the reactor system; therefore, the effects of temperature and pressure excursions resulting from a detonation type reaction are negligible. In addition, the system is designed to include an Emergency Shutdown System to handle temperature and pressure excursions.

Contaminated Surfaces - If red water is allowed to evaporate (e.g., a spill onto the hot reactor), the concentrated solids should be considered an explosive hazard and would likely be susceptible to initiation by impact, friction, heat, or electrostatic discharge. Any such spills should be cleaned using wet methods and not allowed to dry. The exact nature of the dried solids contained in the red water tested should be defined by the characterization analyses.

The impact of operating the reactor under conditions that do not achieve destruction of nitro bodies or treating red water that contains other energetic species not susceptible to oxidation or which behave differently in the process cannot be defined at this time. Solids that precipitate or accumulate on reactor surfaces should be considered potentially dangerous pending the outcome of characterization testing. Therefore, the solids should be kept well diluted until identified. Any measures taken to clean reactor surfaces should be done under water or other suitable solvent. Specific procedures must be developed based on actual hazards as they are assessed.

3.3.2 Sample Collection

Samples of the red water will be collected both before and after it passes through the WAO pilot-scale treatment plant. Additional details of sampling and analysis protocols will be defined in the Test Plan.

During sample collection, there will be an increased chance for leakage to occur due to making connections to the sample line. (It should be noted that no sample points are located on the reactor system, thereby minimizing safety concerns related to the collection of high pressure and high temperature samples.) In addition to the general hazards described previously, additional hazards include: splash of untreated or treated red water onto eyes, face, skin or clothing. Some constituents of the red water may be readily absorbed through the skin and the wastewater may be capable of causing eye irritation and injury. The hazard must be assessed through testing and evaluation of the actual red water.

Hazard controls: All personnel involved in sample collection shall wear the PPE listed in Section 5. Emergency wash facilities capable of providing a 15 minute supply of potable water to eyes, face, or skin shall be provided in the immediate area of sample collection. Personnel whose clothing becomes contaminated shall immediately remove the clothing, wash the affected area with soap and water, obtain dry clothing, and report the incident.

3.3.3 Packaging and Transporting

It is anticipated that the majority of samples will be analyzed on-site by the host facility within 24 hours of collection. A subset of samples will be transported to an off-site laboratory for confirmatory analyses.

Personnel who select packaging, label containers, and determine the proper shipping for hazardous materials shall have completed general awareness and safety training required by DOT Rule 126-F.

If wastewater samples indicate contamination, the waste would be classified as a DOT hazardous substance as defined in 49 CFR § 171.8. Constituents expected to be present in quantities which equal or exceed the reportable quantity (RQ) of the wastewater will be included on the "List of Hazardous Substances and Reportable Quantities". Depending on the wastewater characteristics, the chemicals may be expected to be present in a concentration which equals or exceeds the concentration corresponding to the RQ of the material as listed in 49 CFR § 171.9. If it does not,

the wastewater does not meet the definition of a miscellaneous hazardous materials (Class 9). The expected chemical makeup of the wastewater must also indicate whether it does or does not exhibit the characteristics of any other DOT hazard classes listed in 49 CFR § 173.2.

If DOT hazardous materials regulations are not applicable to the shipment of the wastewater samples, they could be packaged and shipped as nonhazardous materials. Samples should be packed securely so that the containers will not break and, if they do break, the liquid will be contained and/or absorbed inside the shipping container. The outside shipping container(s) should be labeled with "This End Up" labels and the name and address of the shipper and receiving laboratory.

Sample collection, handling, and packaging procedures will be presented in the Test Plans. All samples shipped to off-site labs or delivered to on-site labs will be accompanied by a chain-of-custody form documenting number and dates of samples collected, the sample identification numbers, preservatives added (if any), and required analysis to be conducted on each sample. The chain-of-custody forms will be signed by both the person relinquishing custody and the person receiving the samples as well as space for the receiver to indicate their condition.

Compatibility Segregation. Materials will be segregated according to hazard category:

- Physical State: Separate solids and liquids.
- DOT Hazard Classification: Determine the applicability of DOT hazardous materials regulations. Segregate materials so that each container contains only materials of one DOT hazard class.
- Chemical Compatibility: Segregate materials that will react chemically with each other. For example, do not mix reducers with oxidizers, acids with bases, etc. At this time, incompatible materials are not expected to be encountered.
- Flammable: No flammable samples are expected. However, the nature and hazards associated with the specific materials to be handled must be assessed during the implementation of the next phase of project activity.

Packaging. Ensure the integrity of packaging by observing the following guidelines:

- Laboratory Requirements: Package materials to comply with the requirements of the proposed laboratory.

- **Leaks and Breakage:** Securely close containers before placing in an outside container. Position containers in the outside container so that they do not touch the outside container or other containers.
- **Liquid Sorbent:** Place adequate amounts of absorbent material, such as vermiculite or "Solid-adsorb," to properly cushion to prevent breakage and completely absorb the entire liquid contents of all containers. Containers will be filled with absorbent before closure. Because red water solids may present an explosive hazard, the receiving laboratory must be made fully aware of this hazard and trained as appropriate to handle Class A explosives. The samples must be packaged and shipped in accordance with applicable Army, Department of Transportation, and U.S. Environmental Protection Agency regulations for reactive hazardous wastes and Class A explosives.
- **Sample Preservation to 4°C:** Cool the samples to 4°C prior to placing in the shipping container. Place sufficient pre-frozen gel-filled ice packs in the sample container to keep the samples at 4°C until the container arrives at the laboratory.
- **Chain-of-Custody:** All samples will be accompanied by a chain-of-custody form documenting number and dates of samples collected, the sample identification numbers, preservatives added (if any), and required analysis to be conducted on each sample. The chain-of-custody forms will be signed by both the person relinquishing custody and the person receiving the samples as well as space for the receiver to indicate their condition.

Inventory and Labels. Prepare an inventory for each container packaged and transported from the facility. Label each package with the following types of information:

- Type of sample
- Date
- Inner packs
- Location
- Shipper's name
- Destination.

Sample containers will be labeled with the following information:

- Sampler's name
- Sample type
- Sample location
- Sample preservative.

3.4 CBC Job Hazard Assessment

This initial job hazard assessment identifies potential safety, health, and environmental hazards when conducting the CBC pilot tests and provides for the protection of personnel, the community, and the environment. Because of the complexity and constant change of environmental projects, supervisors must continually inspect the work site to identify hazards which may harm site personnel, the community, or the environment. The TOC Project Engineer must be aware of these changing conditions and discuss them with the TOC's Health & Safety Manager, host facility's Director of Safety, and the host facility's Project Engineer. The TOC Project Engineer will keep supervisors for any subcontractors informed of the changing conditions. The Health & Safety Manager will prepare addenda (see Appendix A), as necessary, to change the job safety analysis and associated hazard controls.

Additional information on hazards associated with the operation of the CBC is presented in the CBC Conceptual Design Report and excerpted in Appendix D.

3.4.1 General Hazard Information

This section discusses the hazards that are anticipated to be encountered during operation of the CBC to burn red water. The potential hazards associated with operation of the CBC include chemical and physical hazards. Chemical hazards were previously presented in Section 3.2; therefore, the following discussion focuses on physical hazards and activity-specific hazards.

Several physical hazards are expected to be encountered during field activities. These hazards are similar to those associated with any mechanical project. These hazards include those due to poor housekeeping, equipment operation, the use of hand and power tools, handling and storage of fuels, and use of electrical power. Specifically, these are:

- Noise hazards
- Heat stress
- Cold stress
- Burn hazards
- Explosion hazards
- Fire hazards
- Confined space entries.

The safety program for these physical hazards is presented in Section 4 of this H&S Plan. It should be noted that the surface of the CBC will be more than 300°F. Therefore, there is a real burn hazard. Other hot spots may be the ash, the baghouse, the fans, the stack, and all duct work.

Burns can be prevented by avoiding contact with hot surfaces and by using the proper protective equipment when working on or near hot surfaces. Further, the auxiliary fuel for the CBC will be natural gas. To prevent an explosive buildup of natural gas in the CBC the following will be observed:

- All auxiliary fuel valves will be installed in a double block and bleed manner
- CBC will be purged with air before the burner is started
- CBC temperature will be above 1300°F before auxiliary fuel is fed directly to the CBC
- Flame sensor will monitor the flame whenever a burner is in operation.

High temperature in the baghouse could cause the bags to catch fire. To prevent this problem, the temperature of the gases before the baghouse will be continuously monitored and if the temperature exceeds the manufacturer's recommended maximum temperature, the auxiliary fuel will be cut off.

The following sections provide an initial analysis of the likelihood of exposure to chemical and physical hazards and the risks associated with those exposures.

3.4.1.1 CBC Installation

The likelihood of exposure to chemical hazards is anticipated to be low, and the associated risk is low.

The likelihood of exposure to physical hazards is anticipated to be low to moderate. Heavy equipment operation and working at elevated locations pose moderate hazards during CBC installation. Other anticipated physical hazards include noise, electrical hazards, pinch points, heavy lifting, fuel handling, and heat stress. Control measures that will be employed to reduce the potential risk of exposure include properly maintained heavy equipment, employee training to recognize physical hazards, and adherence to the heat and cold stress guidelines contained in the H&S Plan.

3.4.1.2 Performance Testing

During the performance test, samples of the red water will be analyzed. The red water may be spiked with organic chemicals and heavy metals, which present potential inhalation and skin

contact hazards during the addition and subsequent sample handling activities. Control measures that can be employed to significantly reduce the potential risk of exposure include enclosed mixing and the use of PPE.

The likelihood of exposure to physical hazards is anticipated to be low to moderate. Equipment operation and material handling activities pose low hazards during trial burn preparation activities. Other physical hazards include heavy lifting, noise, electrical hazards, fire, and elevated work areas. Control measures that should be used to reduce the potential risk of exposure include proper equipment maintenance, trained operators, grounding and bonding during liquid transfer, adherence to lock-out/tag-out procedures, and utilization of proper tie-off procedures.

3.4.1.3 Maintenance Operations

The likelihood of exposure to chemical hazards during maintenance activities is anticipated to be low. The area of concern for this analysis is from the feed port to the stack. All red water that enters the CBC will be combusted, so red water (and its constituents) will not be present in the CBC during maintenance operations. A separate analysis of maintenance of the waste feed system should be considered, but this is beyond the scope of this document.

The likelihood of exposure to physical hazards is anticipated to be low to moderate. The risk associated with exposure to these agents is moderate, based upon the potential for serious injury from electrical hazards, pinch points, and moving equipment. Control measures that will be employed to reduce the potential risk of exposure include employee training and the preparation of site-specific standard operating procedures (SOP). Examples of these procedures include:

- Lockout/tagout procedure
- Confined space entry
- Welding, cutting, and other hot work in hazardous locations
- Isolation of and entry into the CBC.

3.4.1.4 Operation of the CBC

A variety of chemical and physical hazards are associated with the operation of the CBC. The primary control measures include good engineering design, employee training, and the preparation of site-specific SOPs.

The likelihood of exposure to chemical hazards during routine operations is low and should be limited to exposure during sampling of the waste feed and the ash.

The likelihood of exposure to physical hazards is anticipated to be low to moderate. Hazards addressed in the SOPs will include noise, electrical hazards, work at elevations, slip/trip hazards, pinch points, and hot surfaces.

Either a task-specific hazard analysis or an SOP should be developed prior to starting a particular task.

3.4.2 Sample Collection

Sample collection and handling will involve the same considerations discussed in Section 3.3.2.

3.4.3 Packaging and Transporting

Sample packaging and transport will involve the same considerations discussed in Section 3.3.3.

3.5 Control of Hazardous Energy Sources

Hazards: Energy used to power the equipment for this treatability study is anticipated to include electricity, compressed air, hydraulic pressure, and others is hazardous due to the unexpected startup of equipment. Appropriate procedures must be followed during equipment repair or adjustment.

Controls: A program to control hazardous energy (including lockout/tagout provisions) should be implemented prior to the start of operations. This program should be consistent with the OSHA standard 29 CFR 1910.147 (control of hazardous energy sources) and Section 12 of the US Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1). Elements of this program shall include a hazardous energy control plan, lockout-tagout devices, training of affected personnel and periodic inspections of the work area. An example of an energy control plan is included in Appendix E.

3.6 Confined Spaces

Hazards: Potential for entry into confined spaces in or near the project site. A permit-required confined space is a space that:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has a potential for engulfing an entrant
- Is configured such that an entrant could be trapped or asphyxiated
- Contains any other safety or health hazard.

Controls: A confined space program consistent with the OSHA confined space standard 29 CFR 1910.146 shall be implemented. All permit-required confined spaces in or near the project site must be labeled or identified as such. Specifically, a sign reading "DANGER--PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" should be posted at the entrance to any confined space.

Before entry into a permit-required confined space, a permit must be obtained from the site H&S officer. Only properly trained, authorized entrants may enter a confined space. A properly trained attendant must monitor the entrant from outside of the confined space. The appropriate PPE must be worn by the entrant and available for the rescue service.

If confined space entries are necessary during the project, all site personnel will be informed of the location of confined spaces in the project site and the requirements involved with confined space entry. A permit-required confined space decision flowchart is included in Appendix F, to be used as a supplement to the written confined space program at the host facility.

3.7 Hazardous and Toxic Materials

This section lists the currently known and anticipated hazards associated with materials that are likely to be used or encountered during the demonstrations (Table 3-4). The TOC Health & Safety Manager should update this section as information becomes available during the implementation of this project. The TOC's On-site H&S Representative will ensure that MSDSs for all hazardous and toxic materials are include in the revised H&S Plan prior to commencement of mobilization activities. Copies of the H&S Plan and a complete set of MSDSs will be maintained on site by the TOC's On-site H&S Representative.

No more than 25 gallons of flammable/ combustible chemicals shall be stored on site at any time without the use of a flammable storage cabinet. Only compatible materials shall be stored together. Calibration gases and chemicals are to be stored in an area with limited traffic.

Table 3-1 Available Characteristics of Red Water

<u>Parameter</u>	<u>Unit</u>	<u>Concentration/Range</u>
Chemical Oxygen Demand	mg/L	65,000 - 120,000
Total Solids	% ^a	15 - 30
Specific Gravity	NA	1.1
Nominal Solids Heat Value	BTU/lb	3,200
Suspended Solids	mg/L	32
pH	S.U.	7 - 9.7
Soluble Chloride	mg/L	70
Total Kjeldahl Nitrogen	mg/L	11,129
Nitrate Nitrogen	mg/L	1,739
Nitrite Nitrogen	mg/L	6,788
Ammonia Nitrogen	mg/L	150
Metals	mg/L	
Calcium		39 - 346
Iron		4.9 - 307
Magnesium		25 - 90
Potassium		42
Aluminum		2.1 - 10
Chromium		0.14 - 4.9
Barium		0.22 - 3.0
Copper		2.3
Cadmium		0.7
Silver		0.4
Zinc		6.4

* Solids analysis provided on Table 3-2

Source: (PEI, 1990)

Table 3-2 Available Data on the Composition of Red Water Solids

<u>Parameter</u>	<u>Weight Percent</u>
Inorganic Salts	
Na ₂ SO ₃ -Na ₂ SO ₄	32.3
NaNO ₂ (sodium nitrite)	11.2
NaNO ₃ (sodium nitrate)	1.5
NaHS-Na ₂ S (sodium sulfide)	may be present
Sodium bicarbonate/carbonate	may be present
Subtotal Inorganic Salts	45
Nitrobodies	
Sodium sulfonate of 2,4,5 TNT	22.7
a-TNT-Sellite complex	16.2
Sodium sulfonate of 2,3,4 TNT	9.6
Sodium sulfonate of 2,3,5 TNT	2.0
Sodium sulfonate of 2,3,6 TNT	trace
2,4,6-TNBA (trinitrobenzoic acid) Na salt	1.0
White compound sodium salt ^a	1.0
TNBAL-bisulfite addition compound (trinitrobenzaldehyde)	1.0
TNBOH (trinitrobenzyl alcohol)	1.0
Sodium nitroformate	0.5
3,5-DNBA (dinitrobenzoic acid) Na salt	trace
2,3-DNBA (dinitrobenzoic acid) Na salt	trace
TNB (trinitrobenzene)-Sellite complex	trace
Dissolved 2,4-DNT (dinitrotoluene)	trace
Dissolved a-TNT (trinitrotoluene)	trace
Subtotal Nitrobodies	55

^a "White compound" is believed to be 2,2-dicarboxy-3,3,"5,5"-tetranitroazoxybenzene

Source: (PEI, 1990)

Table 3-3 Analytical Results from Bench-Scale WAO Autoclave Tests

Results of the WAO of Diluted Red Water (1:100) at $P_{O_2} = 19$ psi (@25°C) as a Function of Temperature						
Parameter	Test Run No.					
	Raw	1	2	3	4	5
Operational Conditions	(1:100)					
Set Temp. (S.T.)°C		200	230	260	290	320
P_{vap} , psi		225	406	680	1079	1638
P_{O_2} at S.T., psi		30	32	34	36	38
P_T at S.T., psi		255	438	714	1115	1676
Actual P_T , psi		240-260	420-430	700-740	1125-1130	1650-1700
Actual T, °C		198-205	228-232	258-264	290-291	320-322
pH, unit	7.12	5.10	5.24	4.46	5.43	5.64
Solids, mg/L						
TS	3087	2647	2353	2087	1973	1893
TVS	1353	1007	680	440	267	160
FS	1734	1640	1673	1647	1706	1733
TVS/TS, %	44	38	29	21	14	8
Inorganic Salts, mg/L						
NO_2^-	278	BDL*	BDL	BDL	BDL	BDL
NO_3^-	17	129	147	202	228	198
SO_3	35	BDL	BDL	BDL	BDL	BDL
SO_4^{2-}	378	999	1103	1163	1235	1243
Organic Content, mg/L						
Acetic Acid	BDL	13	31	50	52	44
COD	816	418	238	118	52	18
TOC	454	317	225	147	75	35
Nitrocompounds						
NB	BDL	0.07	0.03	0.16	0.17	0.25
a-TNT	0.80	0.14	0.11	0.11	0.04	0.03
2,4-DNT	0.17	0.24	0.15	0.06	0.08	0.04
2,6-DNT	0.02	0.81	0.90	0.37	BDL	BDL
1,3,5-TNB	1.46	5.33	0.94	0.33	0.25	0.11

* BDL - below detection limit

** Estimated values

Source: (Phull, 1992)

Table 3-3 (continued)

Results of the WAO of Diluted Red Water (1:100) at $P_{O_2} = 19$ psi (@25°C) as a Function of Temperature						
Parameter	Test Run No.					
	Raw	1	2	3	4	5
1,3-DNB	0.05	8.12	23.70	20.18	16.74	2.51
DNTS**						
2,4-DNT-3-SO ₃ Na	42.0	39.1	33.7	28.6	8.4	BDL
2,4-DNT-5-SO ₃ Na	28.0	24.9	9.8	BDL	BDL	BDL
Operational Conditions	(1:100)					
Set Temp. (S.T.) °C		200	230	260	290	320
P_{vap} , psi		225	406	680	1079	1638
P_{O_2} at S.T., psi		143	152	161	170	179
P_T at S.T., psi		368	558	841	1249	1817
Actual P_T , psi		350-360	530-550	790-820	1200-1220	1750-1760
Actual T, °C		200-201	230-231	259-261	290-291	320-322
pH, unit	7.10	3.37	3.41	3.27	3.13	3.05
Solids, mg/L						
TS	3147	2420	2290	1989	1833	1773
TVS	1347	867	693	393	247	127
FS	1800	1553	1607	1596	1586	1646
TVS/TS, %	43	36	30	20	13	7
Inorganic Salts, mg/L						
NO ₂ ⁻	291	BDL*	BDL	BDL	BDL	BDL
NO ₃ ⁻	17	230	275	271	338	336
SO ₃ ²⁻	35	BDL	BDL	BDL	BDL	BDL
SO ₄	360	1001	1068	1160	1208	1216
Organic Content mg/L						
COD	800	278	178	72	30	8
TOC	495	255	228	112	72	30
Nitrobenzenes						
NB	BDL	BDL	0.11	0.06	0.10	0.13

* BDL - below detection limit

** Estimated values

Source: (Phull, 1992)

Table 3-3 (continued)

Results of the WAO of Diluted Red Water (1:100) at $P_{O_2} = 19$ psi (@25°C) as a Function of Temperature						
Parameter	Test Run No.					
	Raw	1	2	3	4	5
a-TNT	0.79	0.16	0.17	0.11	0.06	0.01
2,4-DNT	0.18	0.25	0.35	0.07	0.05	0.01
2,6-DNT	0.02	0.49	0.72	0.36	BDL	BDL
1,3,5-TNB	1.35	12.31	3.74	0.91	0.83	0.32
1,3-DNB	0.04	7.02	21.50	21.33	17.55	5.68
DNT sulfonates**						
2,4-DNT-3-SO ₃ Na	42.0	38.6	32.3	25.6	10.9	BDL
2,4-DNT-5-SO ₃ Na	28.0	22.2	17.4	BDL	BDL	BDL
Operational Conditions	(1:100)					
Set Temp. (S.T.) °C		200	230	260	290	320
P_{Vap} , psi		225	406	680	1079	1638
P_{O_2} at S.T., psi		302	321	340	359	378
P_T at S.T., psi		527	727	1020	1438	2016
Actual P_T , psi		480-520	680-720	980-1020	1380-1400	1900-1940
Actual T, °C		199-201	229-231	259-261	290-291	318-321
pH, unit	7.50	3.22	3.23	3.11	3.00	2.98
Solids, mg/L						
TS	3284	2784	2646	2278	2216	2128
TVS	1522	1032	834	422	362	268
FS	1762	1752	1812	1856	1854	1860
TVS/TS, %	46	37	32	19	16	13
Inorganic Salts, mg/L						
NO ₂ ⁻	236	BDL*	BDL	BDL	BDL	BDL
NO ₃ ⁻	18	307	331	339	334	314
SO ₃ ²⁻	35	BDL	BDL	BDL	BDL	BDL
SO ₄ ²⁻	391	1071	1104	1223	1263	1326

* BDL - below detection limit

** Estimated values

Source: (Phull, 1992)

Table 3-3 (continued)

Results of the WAO of Diluted Red Water (1:100) at P ₀₂ = 19 psi (@25°C) as a Function of Temperature						
Parameter	Test Run No.					
	Raw	1	2	3	4	5
Organic Content, mg/L						
COD	830	275	175	79	60	38
TOC	477	275	224	115	71	50
Nitrobenzenes						
NB	BDL	0.09	0.01	0.06	0.08	0.13
a-TNT	0.67	0.22	0.40	0.41	0.11	BDL
2,4-DNT	0.24	0.42	0.47	0.51	0.03	0.02
2,6-DNT	0.02	0.56	0.78	0.60	BDL	BDL
1,3,5-TNB	1.84	19.92	5.47	0.92	0.36	0.35
1,3-DNB	0.05	8.32	16.67	15.93	14.16	10.04
DNT sulfonates**						
2,4-DNT-3-SO ₃ Na	42.0	31.1	29.4	23.1	8.8	BDL
2,4-DNT-5-SO ₃ Na	28.0	20.2	15.1	BDL	BDL	BDL

* BDL - below detection limit

** Estimated values

Source: (Phull, 1992)

Table 3-4 Chemical Hazards

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b
Acetic Acid	Colorless hygroscopic liquid or crystals with a pungent (vinegar) odor	Inhalation, Skin & eye contact, Ingestion	Eye, nose, and throat irritation	Do not allow victim to rub	Eyes, teeth, skin, respiratory system, (blood and kidney injury evident from ingestion only)	25 mg/m ³	25 mg/m ³ [37 mg/m ³]
Aluminum	Light, silvery-white, soft metallic solid, odorless	Inhalation, Ingestion, Contact	Irritation of skin, eyes, upper respiratory tract (URT), and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	15 mg/m ³ total dust	10 mg/m ³ total dust as Aluminum
Barium	White, odorless solid	Inhalation, Ingestion, Contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	0.5 mg/m ³	0.5 mg/m ³
Cadmium	Silver-white blue tinged lustrous odorless metal	Inhalation, Ingestion, Contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	0.2 mg/m ³ Ceiling 0.6 mg/m ³	0.01 mg/m ³ total dust 0.002 mg/m ³ respirable dust
Calcium (as calcium oxide)	White or grey-white lumps or granular powder odorless caustic	Inhalation, Ingestion, Contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	5 mg/m ³	2 mg/m ³

Table 3-4 (continued)

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b
Chromium	Steel-grey, lustrous metal odorless solid	Inhalation, Ingestion, Contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	1 mg/m ³	0.5 mg/m ³
Copper	Reddish lustrous metal, odorless	Inhalation, Ingestion, Contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	1.0 mg/m ³	1.0 mg/m ³
Dinitro-toluene	Greenish yellow color, odorless self oxidizing combustible	Skin contact, inhalation, ingestion	Yellow stain on skin; eye irritation, pain; ingestion may cause gastritis; inhalation may cause pallor nausea, anemia	Flush skin, eyes with copious amounts of water, low pressure	Skin, eyes, liver	1.5 mg/m ³	1.5 mg/m ³ skin
Iron (as ferric oxide)	Dense dark red powder or lumps	Inhalation	Benign Pneumoconiosis	Respiratory support	Respiratory system	10 mg/m ³ (fume)	5 mg/m ³ (fume)
Magnesium (as magnesium oxide)	Fine odorless white powder, hygroscopic	Inhalation, ingestion, contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	15 mg/m ³ (fume)	10 mg/m ³ (fume)
Potassium (as potassium hydroxide)	White odorless, solid, hygroscopic	Inhalation, ingestion, contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	2 mg/m ³	2 mg/m ³ potential carcinogen

Table 3-4 (continued)

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b
Silver	Ductile malleable lustrous white metal	Inhalation, skin and eye contact	Bluish pigmentation of the skin and conjunctiva	Flush skin, eyes with copious amounts of water; remove to fresh air	Generally where contact occurs	0.01 mg/m ³	0.1 mg/m ³ for silver dust and fume 0.01 mg/m ³ for soluble silver compounds
Sodium Bicarbonate	White crystalline powder or granules; odorless	Inhalation, skin contact	Eyes, nose, throat, and respiratory tract irritation; skin irritation	Flush skin, eyes with copious amounts of water; wash skin with soap and water; remove to fresh air.	Skin, eyes, and mucous membranes lining the respiratory system	None established	None established
Sodium Carbonate	White, odorless, hygroscopic (readily moisture-absorbing) powder with an alkaline taste	Inhalation, skin and eye contact, ingestion	Eyes, nose and throat irritation, sneezing, difficulty in breathing, coughing (inhalation); itching, redness and swelling, conjunctivitis (skin and eyes); mouth, chest and stomach irritation, painful swallowing, stomach cramps (ingestion)	Flush skin, eyes with copious amounts of water only; remove contamination clothing; remove to fresh air, do not use soap	Eyes, skin, respiratory and digestive systems	None established	None established
Sodium Nitrate	Odorless, white pellets	Inhalation, ingestion, contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	None established	None established

Table 3-4 (continued)

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b
Sodium Nitrite	Pale yellow	Inhalation, ingestion, contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	None established	None established
Sodium Sulfate	Odorless white crystals or powder	Inhalation, ingestion, contact	Irritation of skin, eyes, URT, and gastrointestinal tract	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	Particulate N.O.S. 15 mg/m ³ total dust, 5 mg/m ³ respirable dust	None established
Sodium Sulfide	Yellow-pink or white, deliquescent crystals	Inhalation, Skin or tissue contact	Irritation of skin, eyes, and respiratory tract	Flush skin, eyes with copious amount of water; wash skin with soap and water; remove to fresh air. Remove contaminated clothing.	Skin, eyes, respiratory tract	None established	None established
Sodium Sulfite	White crystals or powder, may be exothermic in solution releasing toxic sulfur dioxide gasses	Inhalation, skin contact, ingestion	Skin irritation, upper respiratory irritation, shortness of breath, nausea, headache	Flush skin, eyes with copious amounts of water; remove to fresh air	URT, skin, eyes	Particulate N.O.S. 15 mg/m ³ total dust, 5 mg/m ³ respirable dust	None established
Trinitro-toluene	Yellow sludge or solid, explosive reacts with heavy metals and their salts	Skin contact, inhalation, ingestion	Yellow stain on skin; eye irritant, pain; ingestion may cause gastritis; inhalation may cause pallor nausea, anemia	Flush skin, eyes with copious amounts of water, low pressure	Skin, eyes, liver	0.5 mg/m ³	0.5 mg/m ³ skin

Table 3-4 (continued)

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b
Zinc	Bluish-white lustrous metal, also finely divided forms	Inhalation, ingestion	Throat dryness and irritation, coughing, weakness, dyspnea, and generalized aching; mild drying dermatitis (prolonged skin contact)	Flush skin, eyes with copious amounts of water; wash skin with soap and water; remove to fresh air	Respiratory system	None established	None established

Table 3-4 (continued)

From Hazard Information Provided by the Army on Other Explosives

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b	NIOSH IDLH ^c
1,3-Dinitrobenzene (99-65-0)	Yellow crystals, shock sensitive	Inhalation, ingestion, contact	Irritation to the respiratory tract, formation of hemoglobin; headache, nausea, vomiting, dizziness; yellow color in the eyes, hair, and skin; difficulty in breathing; general weakness, cyanosis; skin irritation, blisters	Eyes: flood eyes with water Skin: flood with water wash with soap and water Inhalation: remove to fresh air Ingestion: call a poison control center	Respiratory tract, skin, eyes, circulatory system	1.0 mg/m ³	1.0 mg/m ³	200 mg/m ³
Diisopropyl methyl phosphorate (1445-75-6)	N/A	Ingestion, inhalation	Irritation of respiratory tract, skin	Eyes: flood eyes with water Skin: flood with water wash soap and water Inhalation: remove to fresh air Ingestion: call a poison control center	Respiratory tract skin, eyes, circulatory system	N/A	N/A	N/A

^a OSHA Permissible Exposure Limit (PEL)

^b ACGIH Threshold Limit Value (TLV) Time-weighted Average (TWA) Short-term Exposure Limit (STEL)

^c NIOSH Immediately Dangerous to Life or Health

Table 3-4 (continued)

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b	NIOSH IDLH ^c
Hexachloroethane (0067-72-1)	Clear, colorless liquid, mild gasoline like odor	Inhalation, contact	CNS depression weakness, muscle twitches; irritation skin, eyes, mucous membranes	Eyes: flood eyes with water Skin: flood with water wash soap and water Inhalation: remove to fresh air Ingestion: call a poison control center	Eyes	1 ppm carcinogen	10 ppm	300 ppm
Hexahydro-1,3,5-trinitro-1,3,5-triazine (121-82-4)	White, crystalline powder explosive	Ingestion, contact	Corrosive irritant to eyes, skin, and mucous membranes, convulsions	Eyes: flood eyes with water Skin: flood with water wash soap and water Inhalation: remove to fresh air Ingestion: call a poison control center	Skin, eyes	N/A	1.5 mg/m ³ (skin)	N/A
Nitrocellulose (9004-70-0)	White amorphous solid. Fire/explosive hazard	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitroguanidine (556-88-7)	Yellow solid High explosive	N/A	N/A	N/A	N/A	N/A	N/A	N/A

^a OSHA Permissible Exposure Limit (PEL)

^b ACGIH Threshold Limit Value (TLV) Time-weighted Average (TWA) Short-term Exposure Limit (STEL)

^c NIOSH Immediately Dangerous to Life or Health

Table 3-4 (continued)

Chemical Name	Physical Characteristics	Routes of Exposure	Exposure Symptoms	First Aid	Target Organs	OSHA PEL ^a	ACGIH TLV TWA [STEL] ^b	NIOSH IDLH ^c
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (2691-41-0)	N/A High explosive	Ingestion (poison)	N/A	N/A	N/A	N/A	N/A	N/A
1,3,5-Trinitrobenzene (99-35-4)	Yellow crystals Explosive	Ingestion, inhalation	N/A	N/A	N/A	N/A	N/A	N/A
Trinitro-glycerol (55-63-0)	Colorless to yellow liquid. Explosive fire hazard	Ingestion, contact, inhalation	Headaches, nausea, vomiting, abdominal cramps, convulsions, reduced blood pressure, vertigo, fainting, respiratory rates, cyanosis	N/A	Circulatory system, respiratory system, skin	0.2 ppm (skin)	0.2 ppm (skin)	N/A
White Phosphorus (7723-14-0)	Cubic crystals; colorless to yellow wax like solid. Spontaneously flammable in air	Ingestion, inhalation	Sweating, nausea, diarrhea, cyanosis, cardiomyopathy, photophobia with myosis, pupil dilation, retinal hemorrhage, congestion of blood vessels; anemia, gastrointestinal effects, brittleness of long bones, necrosis of the jaw	N/A	Liver, eye, bone	100 mg/m ³	0.1 mg/m ³	N/A

^a OSHA Permissible Exposure Limit (PEL)

^b ACGIH Threshold Limit Value (TLV) Time-weighted Average (TWA) Short-term Exposure Limit (STEL)

^c NIOSH Immediately Dangerous to Life or Health

4.0 Safety Program

The following work practices will be observed during all site activities.

4.1 General Practices

- At least one copy of this H&S Plan shall be available at the project site in a location readily available to all personnel.
- Contaminated protective equipment, such as gloves, clothing, hoses, boots, etc., shall not be removed from the work area until it has been cleaned or properly packaged and labeled.
- Legible and understandable precautionary labels which comply with the hazard communication standard shall be affixed prominently to all containers of contaminated scrap, waste, debris, and clothing.
- Removal of contaminated residue from protective clothing or equipment by blowing, shaking, or any other means that disperse contaminants into the air is prohibited.
- No food or beverages shall be present or consumed in the regulated area.
- No tobacco products shall be present or used in the regulated area.
- Contact lenses shall not be worn in the regulated area during any operation involving the potential contact with chemicals.
- Cosmetics shall not be applied within the regulated area.
- Contaminated materials shall be stored in tightly closed containers, in well-ventilated areas.
- Containers and equipment shall be moved only with the proper equipment, and shall be secured to prevent dropping or loss of control during transport.
- Emergency equipment shall be located in readily accessible locations that will remain minimally contaminated in an emergency.
- No single person may lift more than 60 pounds.
- All crew personnel on site shall use the buddy system (working in pairs or teams). If protective equipment or noise levels impair communications, then prearranged

hand signals shall be used for communication. Visual contact shall be maintained between crew members at all times, and crew members must observe each other for signs of toxic exposure. Indication of adverse effects include, but are not limited to:

- Changes in complexion and skin coloration
- Changes in coordination
- Changes in demeanor
- Excessive salivation and pupillary response
- Changes in speech pattern.

Employees shall inform their partners or fellow team members of nonvisible effects of overexposure to toxic materials. The symptoms of such overexposure may include:

- Headaches
- Dizziness
- Nausea
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory tract.

- Visitors to the site shall abide by the following:

- Visitors shall be cautioned to avoid skin contact with wastewater or suspected contaminated surfaces.
- Visitors requesting to observe work must wear all appropriate PPE prior to entry. If respiratory protective devices are necessary, visitors who wish to enter the contaminated zone must produce evidence that they have had a complete physical examination, training, and have been fit tested for a respirator within the past 12 months.
- Visitor inspection in the test area shall be at the discretion of the TOC Project Engineer.

4.2 Fall Protection

Ladders will be ascended and descended facing the ladder, with both hands free. Tools, supplies, and equipment will be raised and lowered by rope, not carried while traversing the ladder. Ladder safety as outlined in OSHA standard 29 CFR 1910.25 through 1910.27 shall be followed. All ladders used shall be type A1 for extra heavy duty service. All work above the floor will be from a secure platform. If more than 6 feet above the floor, the workers will be protected from falling by use of a safety harness (Class III) life belt and lanyard or standard guardrail. Scaffolds

will be ascended by a secure ladder. All scaffolds will be inspected at the beginning of each work shift.

4.3 Test Materials, Equipment, and Drum Handling

Mechanical handling equipment will be used to lift or move equipment and drums. Drums used to receive waste generated by site activities will be properly labeled and removed from the site using proper drum handling equipment and techniques. Loading and unloading of vehicles will be performed by site personnel using hydraulic lift gates on equipment if a loading dock is not available. Dollies and forklifts with specially designed handling equipment will be used to move equipment and drums. Mechanical handling equipment shall be used only by trained personnel. In addition, the following procedures shall be followed:

- The quantity of unknown material tested will be no larger than necessary to adequately perform the test.
- Containers will be opened in a manner to minimize the likelihood of spray or splash in the direction of people close to the container.

4.4 Heat and Cold Illness Prevention

Since project operations may be performed outdoors and with the use of chemical impermeable clothing, heat and cold induced illnesses are possible. The following subsections describe heat and cold stress symptoms and prevention procedures.

4.4.1 Heat Stress

Heat stress is a significant potential hazard associated with the use of protective equipment in hot weather environments. The signs and symptoms of heat stress and the physiological monitoring requirements are discussed below.

Heat Stress Monitoring. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and individual characteristics. Extreme hot weather can cause physical discomfort, loss of efficiency, or personal injury.

Individuals vary in their susceptibility to heat stress. Factors that may predispose individuals to heat stress include:

- Lack of physical fitness
- Insufficient acclimation
- Age

- Dehydration
- Obesity
- Alcohol and/or drug use
- Medical conditions
- Infection
- Sunburn
- Diarrhea
- Chronic disease.

Reduced work tolerance and the increased risk of heat stress are directly influenced by the amount and type of PPE worn. PPE adds weight and bulk, severely reduces the body's normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure.

Signs and Symptoms of Heat Stress. If normal body temperature fails to be maintained because of excessive heat, a number of physical reactions can occur ranging from mild to fatal. Heat-related problems include:

- Heat Rash - caused by continuous exposure to heat and humidity and aggravated by chafing clothes. Heat rash decreases the body's ability to tolerate heat, as well as being a nuisance.
- Heat Cramps - caused by profuse perspiration with inadequate fluid intake. Heat cramps cause painful muscle spasms and pain in the extremities and abdomen.
- Heat Exhaustion - caused by increased stress on various organs to meet increased demand to cool the body. Heat exhaustion causes shallow breathing; pale, cool, moist skin; profuse sweating; and dizziness. Heat exhaustion can be alleviated by promptly moving the affected individual to a cool place to lie down and providing cool fluids to drink.
- Heat Stroke - the most severe form of heat stress. Heat stroke symptoms include hot, dry skin; no perspiration; nausea; dizziness; confusion; strong, rapid pulse; and coma. The body must be cooled immediately to prevent severe injury or death. Relief is possible only by emergency measures that quickly reduce body temperature to avoid irreparable damage to the body.

Heat Stress Prevention. One or more of the following practices will help reduce the probability of succumbing to heat stress:

- Provide plenty of liquids to replace the body fluids lost by perspiration. Fluid intake must be forced because, under conditions of heat stress, the normal thirst mechanism is not adequate to bring about a voluntary replacement of lost fluids.

- Provide cooling devices to aid natural body ventilation; however, these devices add weight and should be balanced against worker comfort.
- If possible, install mobile showers or hose-down facilities to reduce body temperature.
- If possible, provide cool protective clothing.
- If possible, conduct field operations in the early morning.
- Acclimate workers to heat conditions when field operations are conducted during hot weather.
- Train personnel to recognize the signs and symptoms of heat stress and its treatment.
- Rotate personnel to various job duties if possible.
- Provide shade or shelter to relieve personnel of exposure to the sun during rest periods.

Individuals succumbing to the symptoms of heat stress will notify the site H&S officer. Early detection and treatment of heat stress will prevent further serious illness or injury and lost work-time. Proper and effective heat stress treatment can prevent the onset of more serious heat stroke or exhaustion conditions. Individuals having progressed to heat exhaustion or heat stroke become more sensitive and predisposed to additional heat stress situations.

Physiological Monitoring. Ambient temperature and other environmental factors provide basic guidelines to implement work/rest periods. However, because individuals vary in their susceptibility to heat stress, physiological monitoring will be used to regulate each individual's response to heat stress when ambient temperatures exceed 70°F. Monitoring frequency will increase as ambient temperature increases. The three physiological parameters that each individual will monitor are:

- **Heart Rate** - each individual will count his/her radial (wrist) pulse for 30 seconds as early as possible in the first rest period. If the heart rate of any individual on the sampling team exceeds 100 beats per minute at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same.

- Oral Temperature - each individual will measure his/her oral temperature with a single-use clinical thermometer for 1 minute as early as possible in the first rest period. If the oral temperature exceeds 98.6°F at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same.
- Body Water Loss - each individual will weigh his/her self before starting work and at the end of each work shift.

An individual is not permitted to return to work if his/her oral temperature exceeds 100.4°F.

Physiological monitoring information will be recorded on the Employee Record for Heat Stress. All monitoring will be performed by persons with a minimum of current Red Cross first-aid certification and individualized training to recognize the symptoms of heat stress. The site H&S officer will specify the work cycle period and the rest cycle period based on heat stress monitoring as per 1991-1992 ACGIH Threshold Limit Values (TLV).

4.4.2 Cold Stress

At certain times of the year, workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite and hypothermia, as well as slippery working surfaces, brittle equipment, and poor judgement.

To minimize the risk of the hazards of working in cold environments, workers will be trained to recognize the physiologic responses of the body to cold stress.

Physiologic Response to Cold Stress. Personnel who are exposed to temperatures below -10°F with wind speeds of greater than 5 miles per hour (mph) will be medically certified as suitable for such exposure. Employees will be protected from exposure to cold so that their body core temperature does not fall below 98.6°F. Lower body temperatures result in reduced alertness and a reduction in thought processes or loss of consciousness.

Pain in the extremities (i.e., fingers, toes, ears, and nose) may be the first signs of cold stress, because these areas have high surface area-to-volume ratios. Uncontrollable shivering occurs during exposure to cold when the body core temperature falls below 95°F. This symptom should be taken as a sign of danger, and work terminated with workers moving to a warm environment.

Ambient air temperature and the velocity of the wind influence the development of a cold injury. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. As a general rule, the greatest incremental increase in wind chill occurs when a 5-mph wind increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical protective clothing is removed and clothing beneath is soaked with perspiration.

Signs and Symptoms of Cold Stress. Local injury resulting from cold is included in the generic term "frostbite;" however, there are several degrees of damage. Cold-related injuries include:

- Frost nip or incipient frostbite is characterized by sudden whitening or blanching of the skin.
- Superficial frostbite gives the skin a waxy appearance and is firm to the touch, but the tissue beneath is resilient. Superficial frostbite can be treated by covering the cheeks with warm hands, placing frostbitten fingers beneath the armpit next to the skin, or placing frostbitten feet beneath the clothing against the skin of a companion.
- Deep frostbite is characterized by cold, pale, and solid tissues. Deep frostbite is an extremely serious injury and affected individuals will seek medical attention.
- Systemic hypothermia is caused by exposure to freezing and rapidly dropping temperatures. Hypothermia symptoms are visually exhibited in five stages:
 - Shivering
 - Apathy, listlessness, sleepiness, and sometimes rapid cooling of the body to less than 95.5°F
 - Unconsciousness, glassy stare, slow pulse, and slow respiratory rate
 - Freezing of the extremities
 - Death.

Cold Stress Prevention. Prevention of frostbite is a function of whole-body protection:

- Adequate insulated clothing should be worn when the air temperature is below 40°F. Insulated coveralls, thermal socks, long underwear, hard hat liners, and other cold-weather gear aid in the prevention of hypothermia.

- Warm break areas and drinks (no caffeinated coffee) aid in warming the body.
- Train personnel to recognize the signs and symptoms of cold-related injuries and their treatment.
- Personnel will try to keep from getting their bodies and clothing wet, as this will only accelerate the effects of cold stress. However, if personnel should get wet, they will be allowed to dry off and change clothes.
- In addition, reduced work periods may be necessary in extreme conditions to allow rest in a warm area.

4.5 Hearing Conservation

All on-site personnel shall wear hearing protection, with a Noise Reduction Rating (NRR) of at least 20, when noise levels exceed 85 DBA. All on-site personnel who may be exposed to noise shall also receive baseline and annual audiograms and training as to the causes and prevention of hearing loss. Noise monitoring is discussed in Chapter 8.0.

Whenever possible, equipment that does not generate excessive noise levels will be selected for this project. If the use of noisy equipment is unavoidable, wherever possible, barriers, or increased distance will be used to minimize worker exposure to noise.

4.6 Confined Spaces

Procedures for confined space entries are described in Section 3.6.

4.7 Sanitation

Sanitary conveniences will be provided and maintained at the testing facility. All on-site personnel shall keep support and work areas neat, clean, and orderly. Trash, refuse, waste, and debris are removed and placed in proper receptacles promptly.

4.8 Break Area

All eating, drinking and smoking by on-site personnel is restricted to designated break areas at the test facility. Employees must exercise good personal hygiene before eating or drinking.

4.9 Ventilation and Engineering Controls

If the treatment systems generate some gasses during their treatment operation (assuming the system is not a closed system), the gasses and vapors generated during operation must be

discharged through exhaust piping. To prevent the release of potentially toxic or unknown gasses and vapors into the test facility, all pilot plant gas discharge piping shall discharge outside the building at roof level or higher.

5.0 Personal Protective Equipment

Based upon the job hazard analysis, it is expected that project personnel will not need extensive protective clothing, and that the on-site work can be completed in Level D protective clothing. Level C protective clothing will be available on site in the event that an upgrade in the level of protection is needed. If conditions warrant higher levels of protection, site work will be suspended until those conditions can be rectified. Level B protection will be included if confined space entry is planned. This upgrade requires immediate notification of the TOC's Health & Safety Manager and the host facility's Director of Safety.

5.1 Levels of Protection

The levels of protection are outlined as follows:

- Specific levels of protection will be reviewed whenever site conditions change. They may either be increased to the next higher level or decreased to the next lower level if conditions warrant.
- The decision to change levels of protection will be made by the host facility's Director of Safety or the TOC's Health & Safety Manager with input from the Project Manager and the Project Engineers.
 - If the need arises to protect Health & Safety, the Project Engineer can upgrade protection levels without input from the TOC's Health & Safety Manager or Project Manager. He will then discuss the decision with the TOC's Health & Safety Manager and host facility's Director of Safety when they are available.
 - Levels of protection will not be downgraded without prior approval from the TOC's Health & Safety Manager and the host facility's Director of Safety.
- After each use, the respirator will be wiped with a disinfectant, cleansing wipe. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag.

5.1.1 Modified Level D Protection

The minimum level of protective equipment to be worn on site during this project is:

- Hard hat
- Face shield
- Safety glasses with side shields

- Steel-toed boots or shoes
- Tyvek coveralls.

During sample collection or chemical handling activities, or other operations where skin contact with contaminated surfaces is likely Nitrile gloves (may be surgical-style gloves such as N-Dex) will be added to minimum requirements for Level D protection.

During activities conducted in close proximity to heated surfaces, heat-resistant type gloves will be added to the minimum requirements for Level D protection.

5.1.2 Level C Protection

Level C protection shall be required if airborne concentrations of hazardous materials exceed one half OSHA's permissible exposure limit (PEL) as determined by personnel monitoring. The main components of Level C protection include full-facepiece air purifying respirator and chemical resistant clothing. The TOC's Health & Safety Manager and the host facility's Director of Safety shall be notified if the need exists to upgrade to Level C.

5.1.3 Level B Protection

Level B protection will be required if airborne concentrations of hazardous materials exceed or are expected to exceed by 10 times OSHA's permissible exposure limit (PEL) as determined by personnel monitoring. The main components of Level B protection include full-facepiece SCBA and chemical resistant clothing. Level B shall be used if confined space entry is permitted by a trained confined space entry supervisor. The TOC's Health & Safety Manager and the host facility's Director of Safety will be notified if the need exists to upgrade to Level B.

Level B protection will also be required for all work where confined space atmospheres contain contaminants in excess of two times the permissible exposure limit (PEL).

5.1.4 Level A Protection

Level A protection is not anticipated.

5.1.5 Selection of PPE

The level of personal protection selected may be changed based upon real-time air monitoring of the work environment and an assessment by the TOC's Health and Safety Manager and the host

facility's Director of Safety of the potential for skin contact with contaminated materials. The PPE selection matrix is given in Table 5-1.

5.2 Respiratory Protection Program

The site respiratory protection program will consist of the following:

- All site personnel will have an assigned respirator.
- All site personnel must be fit tested within the last 12 months and must be qualified in the use of an air purifying and supplied air respirator (because the site personnel may be required to wear Level B PPE). Fit test and respirator qualification cards must be provided to the TOC's H&S representative and the host facility's Director of Safety prior to commencing site work.
- All site personnel must within the past year have been medically certified as being capable of wearing a respirator. Documentation of the medical certification must be provided to the TOC's H&S representative and the host facility's Director of Safety prior to commencement of site work.
- Only properly cleaned, maintained, NIOSH-approved respirators are to be used on the site.
- If respirators are used, the respirator cartridge is to be disposed of at the end of each work shift, or when load-up or breakthrough occurs.
- Contact lenses are not to be worn when respirators are required.
- All site personnel will be clean shaven. Mustaches and side burns are permitted, but they must not touch the sealing surface of the respirator.
- Respirators will be inspected, and a positive, negative pressure test performed prior to each use.
- After each use, the respirator will be wiped with a disinfectant, cleansing wipe. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag.
- Visitors who have not been fit tested or do not have medical clearance must be accompanied at all times by on-site personnel and will not be permitted in areas requiring respiratory protection.

5.3 Donning and Doffing Procedures

Personal protective equipment shall be donned (put on) in a clean support zone. Personal protective equipment shall be doffed (taken off) in a designated area of the contamination reduction zone. Used disposable PPE will be disposed of in nearby designated receptacles. Nondisposable contaminated clothing will be decontaminated prior to reuse.

Table 5-1 PPE Selection Matrix

Parameter	Reading ¹	Action
Total Hydrocarbons	< 5 ppm 5 to 25 ppm > 25 ppm	Normal operations Don respirator and other necessary Level C PPE Stop work and evacuate area; notify TOC On-Site H&S Representative to investigate cause of reading
Identified Air Contaminant	< ½ x PEL > ½ x PEL and < 10 x PEL ² > 10 x PEL	Level D PPE Level C PPE Level B PPE
Total Particulates	< 0.05 mg/m ³ above background 0.05 to 0.5 mg/m ³ > 0.5 mg/m ³	Normal operations; Level D PPE Level C PPE Level B PPE
Flammable Vapors	< 10% LEL > 10% LEL	Normal operations Stop work; ventilate area; investigate source of vapors

Notes:

- 1 ppm denotes parts per million
 PEL denotes permissible exposure limit
 mg/m³ denotes milligrams per cubic meter
 LEL denotes lower explosive limit
- 2 Based on the Protection Factor provided by a half-face respirator.

6.0 Site Control

6.1 Authorization to Enter

Only personnel who have completed training for hazardous waste operations as defined under OSHA Regulation 29 CFR 1910.120 shall be authorized to perform work at this site. All visitors to the site must be coordinated with the TOC and host facility's Director of Safety prior to any visit. The host facility's Director of Safety will maintain a list of authorized persons. That list will be provided to each Project Engineer. Only personnel on the authorized persons list will be allowed within the work area.

6.2 Hazard Briefing

No person will be allowed in project-related field sites during site operations without first being given a site hazard briefing. In general, the briefing will consist of a review of the daily safety meeting. All persons on the site, including visitors, must review and sign the site-specific daily safety meeting form.

6.3 Documentation of Certification

A training and medical file will be established for the project and kept on site during all site operations. All training, updates, and specialty training (first-aid/cardiopulmonary resuscitation [CPR]) certificates, as well as the current annual medical clearance for all project field personnel, will be maintained within that file. The host facility, TOC, and subcontractors will be responsible for maintaining a file of required training and medical documentation for their employees.

6.4 Entry Log

The TOC's Engineer shall record on their Daily Log all visitors on the site.

6.5 Entry Requirements

In addition to the entry requirements listed above, no personnel will be allowed in the site unless they are wearing the minimum PPE as described in Section 5.0. The TOC Project Engineer will record all personnel entries and departures. All site entries will comply with host facility procedures.

7.0 Decontamination

An area will be provided with closable containers for storage of used/contaminated gloves and other PPE and a separate locker or area for storage of other personal protective equipment. All personnel shall remove and discard their gloves after sample collection or other activities which may contaminate the gloves. When personnel leave the site, coveralls shall be removed and stored in a secure location designated by the host facility. The entrance to the project site area will be posted with the following sign: **WORK AREA, NO UNAUTHORIZED ACCESS.**

7.1 Equipment Decontamination

All equipment shall receive washdown and decontamination before being removed from the building. This includes the exterior of sample containers. Removal of any equipment from the site will require specific review and approval by the host facility's Hazards Analysis Department.

7.2 Personal Protective Equipment Decontamination

Non-reusable protective clothing shall be disposed of in marked containers. Depending upon subsequent analysis, that protective clothing may require disposal as hazardous waste.

Reusable protective clothing will be rinsed at the site with detergent and water. The rinsate will be discharged to the host facility's on-site wastewater treatment plant, if available. If a wastewater treatment plant is not available, the rinsate will be drummed for subsequent disposal offsite.

Respiratory protective equipment will be wiped with a damp cloth and bagged. Once the respirator has been removed from the work area, it will be thoroughly cleaned with soap and water. The respirator face piece will be cleaned at the end of each work shift.

8.0 Site Monitoring

8.1 Air Monitoring

Air monitoring will be conducted during the initiation of project work and whenever there is reason to suspect the airborne concentration of any hazardous material exceeds one-half of the OSHA PEL or the ACGIH threshold limit value (TLV).

The TOC's On-site H&S Representative will be responsible for monitoring the breathing zones of site personnel to ensure that the personnel are not exposed over permissible exposure limits. The TOC's On-site H&S Representative will periodically collect air samples in the breathing zone of site personnel, particularly if odors are detected, in accordance with the requirements in Table 8-1. Additional air monitoring may be required after additional process discharge gasses are identified. If an action level in Table 8-1 is exceeded, the TOC's H&S Manager will be notified, the area will be evacuated, and the contaminant will be allowed to dissipate. It will be necessary to don appropriate clothing, respirator, and retest. If levels continue to exceed the action levels, work will be postponed until conditions return to background levels and the host facility's Director of Safety will be contacted for assistance. In the case of noise, exceedance of action levels will trigger the use of hearing protection only.

8.2 Monitoring Recordkeeping

The TOC's On-site H&S Representative will be responsible for establishing and maintaining records of all required monitoring as described below:

- Employee name, social security number, payroll number
- The date, time, pertinent task information, exposure information
- Description of the analytical methods, equipment used, calibration data
- Type of PPE worn
- Engineering controls used to reduce exposure.

8.3 Hazardous Conditions

The TOC's On-site H&S Representative shall take affirmative action to limit exposures. He shall contact the TOC's Health & Safety Manager and the host facility's Director of Safety to evaluate especially hazardous situations, or any situation with a large risk of hazardous exposure. Operations will proceed only if they can be accomplished in a safe manner.

8.4 Noise Monitoring

Noise monitoring will be conducted as required. Hearing protection is mandatory for all employees in hazardous noise areas around operating machinery.

On-site personnel must wear monitoring equipment as instructed by the TOC's On-site H&S Representative. Refusal to wear monitoring equipment or intentional tampering with sampling apparatus will lead to immediate dismissal from the job site.

All equipment used on site will be monitored during its first use and assigned and labeled with a noise level. Personnel will be notified of all equipment which requires the use of hearing protection.

8.5 Heat Stress

Heat stress monitoring shall be initiated whenever ambient temperatures on site exceed 85° F during tasks requiring only D level PPE. Should PPE be upgraded, heat stress monitoring will be initiated at 70° F. At the discretion of the host facility's Director of Safety and TOC's Health & Safety Manager, environmental and/or physiologic monitoring will be carried out. Monitoring and interpretation of monitoring results will be in accordance with the Threshold Limit Values for Heat Stress published by the American Conference of Governmental Industrial Hygienists.

8.6 Safety Review

At least once during the project, both the TOC's Project Manager and the TOC's Health & Safety Manager (or designee) will conduct a comprehensive safety review of the project. The TOC's On-site H&S Representative will conduct frequent site safety inspections (no less than once per week). The TOC's Management Safety Reviews will be recorded on Safety Inspection Report Forms and will be forwarded to the TOC's Project Manager and Corporate H&S Manager for review. The TOC's Project Manager will record the inspection results on the Safety Inspection Report.

8.7 Notification

Within 5 working days after receipt of monitoring results, the project Health & Safety staff will ensure that each employee is informed in writing of the results which represent that employee's exposure. Monitoring results representative of an employee's exposure shall be reported to the affected employee on the TOC Employee Notification of Industrial Hygiene (IH) Monitoring Results

Form, with results forwarded to the employee's "home" office for inclusion in the individual employee file.

Whenever the results indicate that the representative employee exposure exceeds the PEL, the Employee Notification of Industrial Hygiene Monitoring Results Form shall state that the PEL was exceeded, and shall provide a description of the corrective action taken to reduce exposure to a level below the PEL.

The TOC will provide IH monitoring results to the respective subcontractor if the exposure of TOC or subcontractor employees to airborne contaminants is elevated. The TOC will provide a summary of the IH monitoring results to USAEC's Safety Branch.

Table 8-1 Air Monitoring Protocol¹

Parameter/ Contaminant	PEL	Monitoring Equipment	Sampling and Analytical Method	Frequency of Sampling
Aluminum	15 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) ICP NIOSH 7013	Once at work start-up. Additional sampling to be determined for those parameters at or above the action level.
Acetic Acid	25 mg/m ³	Colorimetric detector tube (CDT)	Direct reading instrument (DRI)	Same
Barium	0.5 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) Atomic Absorption (AA) NIOSH 7056	Same
Cadmium	0.2 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) AA NIOSH 7048	Same
Calcium (as calcium oxide)	5 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) AA NIOSH 7024	Same
Chromium	1 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) AA NIOSH 7024	Same
Copper	1.0 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) AA NIOSH 7029	Same
Dinitrotoluene	1.5 mg/m ³	Filter of mixed cellulose and 10 ml ethylene glycol bubbler HPLC	NIOSH S-215	Same

Notes: 1 - Action levels and actions presented on Table 5-1.

Table 8-1 (continued)

Parameter/ Contaminant	PEL	Monitoring Equipment	Sampling and Analytical Method	Frequency of Sampling
Iron (as ferric oxide)	10 mg/m ³ (fume)	Mixed cellulose ester filter	X-ray fluorescence spectrometry (XRF) NIOSH 7200	Same
Magnesium (as magnesium oxide)	15 mg/m ³ (fume)	Mixed cellulose ester filter	Acid (NIOSH 7300) ICP NIOSH 7300	Same
Noise	90 dBA	Sound level meter	DRI	Same
Potassium (as potassium hydroxide)	2mg/m ³	Mixed cellulose ester filter	NIOSH 7401	Same
Silver	0.01 mg/m ³	Mixed cellulose ester filter	Acid (NIOSH 7300) ICP NIOSH 7300	Same
Sodium Bicarbonate	None established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Carbonate	None established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Sulfate	15 mg/m ³ total dust	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Sulfide	None established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Sulfite	15 mg/m ³ total dust	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same

Notes: 1 - Action levels and actions presented on Table 5-1.

Table 8-1 (continued)

Parameter/ Contaminant	PEL	Monitoring Equipment	Sampling and Analytical Method	Frequency of Sampling
Sodium Nitrate	None Established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Nitrite	None Established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Sulfonate	None Established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Sodium Nitroformate	None Established	Mixed cellulose ester filter	Ion chromatography NIOSH 7903	Same
Trinitrotoluene	0.5 mg/m ³	OSHA 44	GC-TEA-EAP	Same
Zinc	None established	Mixed cellulose ester filter	Acid (NIOSH 7300) ICP NIOSH 7300	Same

Notes: 1 - Action levels and actions presented on Table 5-1.

9.0 Employee Training

9.1 General

All on-site project personnel shall have completed at least 40 hours of hazardous waste operations-related training and 24 hour of supervised on the job training for RCRA regulated treatment, storage or disposal (TSD) facilities, as required by OSHA Regulation 29 CFR 1910.120 (O). Those personnel who completed the 40-hour training more than 12 months prior to the start of the project shall have completed an 8-hour refresher course within the past 12 months. The Project Engineer shall have completed an additional 8 hours of supervisory H&S training. At least one person on site shall have a current first-aid/CPR certificate. Subcontractor personnel must meet the above training requirements.

Each employee who completes the required 40 hours of classroom training shall have a certificate signed by the instructor. All contractors must provide certificates of training for the project file for all employees assigned to the project.

Visitors shall be escorted at all times while on site regardless of training.

9.1.1 Daily Safety Meetings

Prior to the start of the project, all personnel will participate in a daily safety meeting. During the safety meeting, the Site H&S Representative will ensure that the anticipated site hazards are summarized and explained to all personnel, and that those personnel are aware of the precautions they must take to minimize their exposure to those hazards. Safety meetings will be held at the start of each work shift. All new employees must attend the meeting and be familiar with this H&S Plan.

Attendance records and meeting notes are maintained with the TOC project files.

9.1.2 Material Safety Data Sheets

Material Safety Data Sheets (MSDSs) and occupational health guidelines for chemical substances known to be on site are included in Appendix G. The H&S Plan is to be maintained on site and is accessible to all site employees. Each employee is required to review and sign the H&S Plan before starting work on the site.

9.1.3 Site-Specific Health and Safety Plan

The Final H&S Plan for this project shall be prepared to conform with the requirements of 29 CFR 1910.120. The Project Engineer shall present the H&S Plan and discuss it with all personnel assigned to the project. All workers and visitors must read and sign the H&S Plan acknowledging acceptance of site rules and understanding of site hazards before the start of the site work.

9.2 Site-Specific Training

All on-site personnel, except authorized visitors, must undergo site-specific training through completion of host facility orientation and training, confined space awareness, lockout/tagout training, and a review of this H&S Plan and the daily safety meetings.

9.3 First Aid and Cardiopulmonary Resuscitation

At least one employee current in first aid/CPR will be assigned to the work crew and will be on the site whenever operations are ongoing. Annual refresher training in CPR is required to maintain the currency of the certificate.

10.0 Medical Surveillance

10.1 Medical Examination

All on-site project personnel shall have completed a comprehensive medical examination within the past 12 months that meets the requirements of OSHA Regulation 29 CFR 1910.120. The annual medical examination should include the following elements:

- Medical and occupational history questionnaire
- Physical examination
- Complete blood count, with differential
- Liver enzyme profile
- Chest X-ray, once every three years, for non-asbestos workers
- Pulmonary function test
- Audiogram
- Electrocardiogram for persons older than 35 years of age, or if indicated during the physical examination
- Drug screening
- Visual acuity
- Follow-up examinations, at the discretion of the examining physician or the corporate medical director.

All employee medical records shall be maintained by the H&S group at each contractor's office. The examining physician provides the employee with a letter summarizing his findings and recommendations. Each employee also has the right to inspect and copy his medical records.

The examining physician provides the employer with a letter confirming the worker's fitness for work and ability to wear a respirator. A copy of this letter for all project workers will be kept on site during all project site work.

Each contractor shall certify that its employees have successfully completed a physical examination by a qualified physician and the physical examinations meet the requirements of 29 CFR 1910.120, 29 CFR 1910.134. Each contractor shall supply copies of the medical examination certificate for each on-site employee.

10.1.1 Placement Examination

All employees will receive a placement medical examination prior to assignment to field operations.

10.1.2 Annual Examination

Each year, subsequent to the placement examination, all site personnel including the TOC and subcontractor staff must undergo an annual examination, similar in scope to the placement examination.

10.2 First-Aid and Medical Treatment

All persons on site must report any near-miss incident, accident, injury, or illness to their immediate supervisor and the Project Engineer. First aid will be provided by the designated site first aider.

For TOC personnel, injuries and illnesses requiring medical treatment will be accompanied by an "Authorization for Treatment Form." The employee's supervisor or the Project Engineer will complete the "Supervisor's Employee Injury Report" and conduct an accident investigation as soon as emergency conditions no longer exist and first-aid and/or medical treatment has been ensured. The investigation should follow the Accident/Injury Investigation Report. These two reports must be completed and submitted to the Health & Safety Manager within 24 hours after the incident.

Subcontractor personnel will follow existing host facility protocols for internal notifications.

A first aid kit will be kept within the test facility in the case that first-aid treatment is required. If treatment beyond first aid is required, the injured should be transported to the medical facility designated in Section 1.2. If the injured is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedics should be summoned. If there is any doubt as to the injured worker's condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

10.3 Medical Restriction

When a medical care provider identifies a need to restrict work activity for any TOC or subcontractor personnel, the employee's H&S Manager will communicate the restriction to the employee and their supervisor. The terms of the restriction will be discussed with the employee and their supervisor. Every attempt will be made to keep the employee working, while not violating the terms of the medical restriction.

10.4 Medical Records

Medical and personal exposure monitoring records will be maintained according to the requirements of 29 CFR 1910.20, and shall be kept for 30 years post-employment. Employee confidentiality shall be maintained. Employees and their authorized representatives shall have access to these records.

11.0 Emergency Procedures

This H&S Plan has been developed to ensure that the red water pilot-scale treatment plant test demonstrations may be conducted without adverse impact to the Health & Safety of project personnel, other personnel, and the environment. Supplementary procedures are included in this section to address extraordinary conditions that might occur at the site.

11.1 General

The TOC's On-site H&S Representative, in coordination with the facility's Director of Safety, will establish evacuation routes and assembly areas. All personnel entering the project site will be informed of these routes and assembly areas. If the evacuation routes are not clear, a site plan will be made marking the evacuation routes and will be posted at conspicuous locations.

[specific procedures for the project site to be inserted]

11.2 Emergency Procedures

If an incident occurs, the following procedures will be followed and performed by the host facility's Project Engineer and the TOC's Project Engineer:

- Evaluate the incident and assess the need for assistance
- Call for outside assistance as needed
- Act as liaison between outside agencies and on-site personnel
- Ensure the host facility's Director of Safety, the TOC's Project Manager, and the USAEC are notified promptly of the incident
- Take appropriate measures to stabilize the incident scene.

A list of emergency contacts is presented in Section 11.5.

11.3 Safety Signals

[specific safety signals for the project site to be inserted]

11.4 Medical Emergency

All employee injuries must be promptly reported to the host facility's Project Engineer and the TOC's Project Engineer, who will:

- Ensure that the injured employee receives prompt first aid and medical attention
- Ensure that the host facility's Director of Safety, the TOC's Project Manager and General Manager, and the USAEC are promptly notified of the incident
- Initiate an investigation of the incident.

11.4.1 Chemical Inhalation

Any employee complaining of symptoms of chemical overexposure will be removed from the work area and transported to the designated medical facility for examination and treatment. It is highly unlikely that the chemicals anticipated as being on the work site, in the concentrations anticipated, would cause situations immediately dangerous to life and health.

11.4.2 Eye Contact

Project personnel who have had contaminants splashed in their eyes or who have experienced eye irritation while in the pilot plant work area, shall immediately proceed to the eyewash station positioned within the work zone. Flush the eye with clean running water for at least 15 minutes. Arrange prompt transport to the designated medical facility.

11.4.3 Skin Contact

Project personnel who have had skin contact with contaminants will proceed to the wash-up area. Personnel will remove any contaminated clothing and then wash the affected area with water for at least 15 minutes. The worker should be transported to the medical facility listed in Section 11.5.1, if they show any sign of skin reddening, irritation, or if they request a medical examination.

11.4.4 Personal Injury Accident

In the event of a personal injury accident, the site supervisor will assess the nature and seriousness of the injury. In the case of serious or life-threatening injuries, normal decontamination procedures may be substituted with covering the injured party with plastic sheeting to reduce the spread of contamination and informing necessary hospital staff. Less serious injuries such as strains, sprains, minor cuts, and contusions may only be treated after the employee has been decontaminated.

Following decontamination, a project team member qualified in first aid and CPR will administer suitable first aid. The site H&S Representative will then, if necessary, arrange transport to the appropriate medical facility.

11.5 Emergency Contacts

[site specific procedures to be presented here]

11.5.1 Emergency Facilities

[site specific information (e.g., Fire, Ambulance, Police, and Hospital) to be presented here]

11.5.2 Key Host Facility, TOC, and Subcontractor Personnel

[project specific information to be presented here]

11.5.3 Reporting Requirements

All accidents and incidents no matter how minor must be reported to the host facility's Director of Safety, the TOC's Project Manager, and to the USAEC. The TOC's Project Manager must notify, by telephone, the USAEC in the event of accidents resulting in a fatality, lost-time injury or illness, hospitalization of three or more personnel, or property damage to government or contractor property (which occurred during the performance of the contract) equal to or exceeding \$2000 as soon as possible, but no later than 2 hours after occurrence, and must report these events on DA Form 285 within 5 days of occurrence. The TOC's Project Manager must report all other accidents/incidents by telephone to USAEC, SFIM-AEC-TTS, (410) 681-4811, within 8 hours of occurrence.

12.0 References

Hercules, Inc. 1973. *Final Engineering Report on Production Engineering Projects PE-238 and PE-289.*

Hercules, Inc. 1991. *Hazard Analysis of TNT Red Water Wet Air Oxidation.*

IT Corporation. 1993a. *Minutes of Red Water Project Meeting at Radford Army Ammunitions Plant.* Contract No. DACA31-91-D-0074, Task Order No. 0003.

IT Corporation. 1993b. *Evaluation of Six Options for Obtaining Red Water.* Prepared for the U.S. Army Environmental Center. Contract No. DACA31-91-D-0074, Task Order No. 0003. April 1993.

PEI Associates, Inc. 1990. *Technology Evaluation for Treatment/Disposal of TNT Red Water.* Prepared for U.S. Army Toxic and Hazardous Material Agency. Contract No. DAA15-88-D-001.

Phull, Kotu Kumar. 1992. *Wet Air Oxidation of TNT Red Water.* Ph.D. Dissertation, University of Maryland.

Zimpro Environmental, Inc. 1992. *Bench-Scale Shaking Autoclave Results for Wet Air Oxidation System Treatment of a TNT Process Waste (Red Water) From the U.S. Army.*

APPENDIX A

SITE SAFETY AND HEALTH PLAN AMENDMENTS

Site Safety and Health Plan Amendment # _____:

Site Name: _____

Date: _____ Type of Amendment: _____

Reason for Amendment:

Alternate Safeguard Procedures: _____

Required Changes in PPE: _____

TOC Project Engineer/Date

TOC Safety & Health Manager/Date

Host Facility Project Engineer/Date

Host Facility Director of Safety/Date

APPENDIX B

**HAZARD ANALYSIS OF TNT RED WATER
WET AIR OXIDATION
(Hercules, Inc. 1991)**

from S. Maloney - CERL
12/6/93

HERCULES INCORPORATED
HERCULES AEROSPACE COMPANY
ALLEGANY BALLISTICS LABORATORY
ROCKET CENTER, WEST VIRGINIA

HAZARD ANALYSIS OF TNT RED WATER WET AIR OXIDATION

APRIL 26, 1991

D. A. HULBURT

PREPARED FOR

U. S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY
CHAMPAIGN, ILLINOIS

AO2052-520-03-001

HERC NO. 91-23

WARRANTY

"HERCULES warrants that it has performed the analysis required by the statement of work in a safe and competent manner and in accordance with the standards employed by HERCULES in performing the same or similar analysis for itself. ANY OTHER PROVISIONS OF THIS AGREEMENT TO THE CONTRARY NOT WITHSTANDING, THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED, WHETHER ARISING BY LAW, CUSTOM OR CONDUCT INCLUDING WITHOUT LIMITATION, THOSE OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, THAT ACCIDENTS OR HAZARDS OF ANY KIND WHATSOEVER WILL BE ELIMINATED, THAT ANY PARTICULAR STANDARD OR CRITERION OF HAZARD OR ACCIDENT ELIMINATION OF ANY KIND WHATSOEVER WILL BE ACHIEVED OR THAT ANY PARTICULAR OR ANTICIPATED RESULTS OF ANY KIND WHATSOEVER WILL BE ACHIEVED BY OWNER'S USE OR APPLICATION OF ANY OF THE INFORMATION, ADVICE, RECOMMENDATIONS OR SERVICES PROVIDED IN WHOLE OR IN PART BY HERCULES. ALL SAID INFORMATION, ADVICE, RECOMMENDATIONS OR SERVICES ARE FOR THE SOLE USE OF OWNER AND ARE USED AT OWNER'S RISK. THE RIGHTS AND REMEDIES PROVIDED HEREIN ARE EXCLUSIVE AND IN LIEU OF ANY OTHER RIGHTS OR REMEDIES WHETHER ARISING BY LAW, CUSTOM OR CONDUCT."

CAUTION

Conclusions presented in this hazards analysis report are based upon the hardware (or design), materials of construction, operating conditions, process materials and procedures as they existed at the time of the analysis (or as they were presented to Hercules for analysis). If changes in any of these parameters occur in the future, the conclusions of the current hazard analysis may be invalidated.

I. SUMMARY

A hazard review of the bench-scale system for studying TNT Red Water Treatment by Wet Air Oxidation has been completed. This system is comprised of a 2-Liter Stirred Parr Reactor, Oxygen Supply system, Sample Injection system, and Liquid Sampling system. The hazard review considered two modes of operation of the process: 1) Batch Mode, and 2) Injection Mode.

It is concluded that the system as designed can be used safely. Findings and recommendations for maximizing safety are summarized below.

1. Procedures for using the system in each of the two modes should be reduced to formal written procedures, which should be followed to minimize the chance of operational errors.
2. During experimental runs, a warning sign that high pressure/high temperature operations are in progress should be posted at the laboratory entrances. Access of transients should be controlled to reduce personnel to the minimum consistent with conduct of the experiment.
3. Each source of red water should be analyzed prior to use to confirm its characteristics are within normal tolerances of the red water studied previously, and upon which this analysis and conclusions are based. Red water of significantly different characteristics should not be used until and unless a specific evaluation confirms they can be safely processed.
4. Minimum dilution for red water with characteristics representative of RAAP Red Water should be 10:1. A more conservative 20:1 dilution should be used for the higher solids red water obtained from ICI Canada until and unless it is established its heating value is no higher than RAAP red water. (It may be possible to relax the dilution ratio once better reaction pathway and kinetic data are available).
5. If the process is scaled-up to pilot or production scale, it would be prudent to install the reactor within a reinforced concrete bay.
6. Present practice of limiting liquid charge to 50% of reactor volume is adequate for operating temperatures of 340 deg-C or less.
7. Any future modifications must consider compatibility of the structural material with oxygen at the operating conditions of the process.
8. A face shield should be minimum requirements to protect the eyes and face in the event of a leak or rupture disc operation on the unit. Additional protection (e.g., gloves, lab apron) are minimal requirements during liquid sampling while the reactor is under pressure.
9. Consideration should be given to installing a screen cage around the reactor to preclude inadvertent contact with hot surfaces.
10. Any precipitate or accumulation on reactor surfaces should be regarded as potentially explosive until established otherwise, and should be handled in a dilute state.

II. INTRODUCTION

A. BACKGROUND

In the nitration of toluene to produce 2,4,6-trinitrotoluene (sym-TNT) other unsymmetric isomers of TNT as well as secondary oxidation products are formed. Purification of the sym-TNT involves reacting the nitration products with sodium sulfite (Sellite). This solubilizes the isomers as DNT-sulfonates, permitting their separation from the desired sym-TNT product. The resulting wastewater develops a characteristic red color, hence it is known as TNT Red Water or simply as Red Water. Red water can no longer be discharged directly to the environment. Means of treating red water to make it "safe" for discharge are being sought.

The Department of Civil Engineering at the University of Maryland is under contract to the US Army Construction Engineering Research Laboratory (CERL) to study the feasibility of using wet air oxidation (WAO) to treat TNT red water, and has issued a Feasibility Study Report (Ref 1). Inasmuch as the WAO process involves elevated temperatures and pressures (300-350 deg-C and 2000 psi typical) and red water contains energetic compounds (e. g., nitrocompounds), CERL concluded it was desirable to have an independent hazard review of the WAO bench scale process performed. CERL issued a contract (DACA88-91-M-0365) to Hercules' Hazard Evaluation and Risk Control Services (HERC®) for the same. This report documents the hazard analysis performed under that contract.

B. STATEMENT OF WORK

The statement of work of the subject contract consists of four tasks as follows:

- | | |
|--------|---|
| Task 1 | Site Visit at University of Maryland |
| Task 2 | Evaluation of thermal explosion scenarios |
| Task 3 | Evaluation of equipment contamination scenarios |
| Task 4 | Written report |

C. BASIS OF ANALYSIS

The hazard review was based on observation of the system and information gained in discussions with the research team during the site visit, data contained in the Feasibility Report (Ref 1), reactor vendor information, and other data and knowledge from the analyst's prior experience and technical resources in the HERC department.

The work scope did not include: 1) OSHA regulations compliance, 2) evaluation of fire protection systems, or 3) operations associated with storage, handling, analysis, or disposal of the untreated or treated red water.

III. DISCUSSION

The site visit to the University of Maryland was made on April 16, 1991. The WAO system was observed and technical discussions were held with members of the research team. In addition to the author, participants in this visit included Dr. Oliver J. Hao (Principal Investigator), K. K. Phull (Graduate Student), and Dr. Steven W. Maloney (CERL Project Officer).

A. OPERATION OF THE WAO BENCH SCALE PROCESS

The heart of the bench-scale system is a 2-Liter Parr Stirred Reactor. This is a packaged unit supplied by Parr Instrument Company. It consists of a Model 4522 reactor with Model 4842 controller. The reactor features a magnetic drive stirrer and serpentine cooling coil. Material of construction is T316SS. For routine operation, the unit is rated for 1900 psig at 350 deg-C. The reactor is protected with a 0.25-inch rupture disc designed to rupture at 3000 psig. The controller features a high-temperature cut-out which shuts down the heater and activates the cooling water system. For purposes of analysis it is presumed the reactor design and fabrication is consistent with the stated operating limits (i. e., a structural analysis to confirm design adequacy was not its scope).

Previous experimental runs have been conducted in what, for brevity, will be referred to as the Batch Mode. It is also contemplated to run studies in what will be referred to as the Injection Mode, to elucidate reaction kinetics. These two modes are characterized as follows:

1. Batch Mode

- Diluted red water is added to the reactor at ambient conditions
- Reactor is charged with oxygen
- Reactor is heated to operating temperature (with associated pressure)
- Reactor is held at operating conditions (typically one hour)
- Reactor is cooled-down using internal cooling coil
- Sample of treated red water is taken for analysis

2. Injection Mode

- Dilution water only is added to reactor at ambient conditions
- Reactor is charged with oxygen
- Reactor is heated to operating temperature
- Red water is injected into reactor
- Periodic liquid samples are removed for analysis
- Reactor is cooled-down at completion of experiment

The system for adding the red water charge is based on "blowing" in the charge with helium pressure, followed by a rinse water charge. There is little concern with this system as long as: 1) it is leak tight, 2) the helium pressure is slightly above reactor pressure (to prevent backflow -- there is also a check valve), and 3) the valves are properly manipulated. The addition procedure should be reduced to a set of formal written instructions.

Taking samples for analysis will involve periodic making and breaking of connections to the sample line, increasing the chances of a leaking connection occurring. Personnel should be protected (gloves, face shield, and lab apron minimum) and sampling procedures should be reduced to a formal set of instructions. The main concern is that the reactor is valved off from the sampling system prior to disconnecting the sample container.

B. HAZARD SCENARIOS

Several potential hazards in addition to those specifically identified in Tasks 2 and 3 in the SOW were identified. They are included in this report for completeness. Identified potential hazards of the Wet Air Oxidation process of treating red water, as practiced at the bench scale, include the following: 1) Oxygen Incompatibility, 2) Hot Surfaces, 3) Hot Spray, 4) Liquid Expansion, 5) Pressurized Gas/Vapor, 6) Thermal Explosion, and 7) Contaminated Surface hazards. Each of these is discussed below.

1. Oxygen Compatibility

As would be expected, pure oxygen is a potent oxidizing agent, particularly at elevated pressures and/or temperatures. All elements of the oxygen supply system must be compatible with oxygen use to preclude the possibility of an incident. Representatives of the research team have indicated that this potential hazard was considered in the selection of components for the oxygen system. Within the reactor, the initial oxygen charge is estimated to be at most on the order of several hundred psi, based on previous test conditions. Oxygen partial pressure will about double during reactor heat-up; at the same time the vaporization of water will reduce the oxygen concentration in the ullage of the reactor. The reported flash point of Teflon is 400 deg-C or greater at oxygen pressures of 1000 psi or less (Ref 2). Thus there does not appear to be a credible compatibility problem with the reactor gasket.

2. Hot Surfaces

The reactor is operated at elevated temperatures (225-340 deg-C). Surfaces of the reactor heater and the head of the reactor are potential burn hazards to personnel during heat-up, operation, and cool-down. Contact with these surfaces should be avoided, or proper protective equipment should be used if it is necessary to handle components above 120 deg-F. The research team may want to consider fabricating a screen cage to surround the unit to prevent inadvertent contact with it, while at the same time allowing normal air circulation. Racing-type gloves may provide greater dexterity than "standard" laboratory "asbestos" gloves for handling equipment at moderately elevated temperatures.

3. Hot Spray

The reactor is operated at elevated temperature and pressure. Any leak in the reactor/piping fittings or operation of the rupture disc would result in a spray of hot flashing liquid which could contact and injure any personnel present. The reactor should be leak checked at operating pressure prior to each use. Strict adherence to the operating temperature limit should be followed. Gaskets will soften/melt if temperature limits are exceeded. A shield has been installed to deflect spray from the relief stream in the event of disc rupture. Use of a face shield is recommended for any personnel present when the system is pressurized. This hazard is considered more likely in the Injection Mode, which requires periodic making and breaking of connections.

4. Liquid Expansion

The predominant constituent of the reactor charge is water. Water has a particularly large liquid volume expansion upon heating. If the reactor is overcharged, the liquid volume could increase until it occupied the entire reactor volume. Any additional heating would then result in overpressurizing the reactor and operation of the rupture disc. The expansion ratio from ambient (25 deg-C) to the temperature limit of the reactor (350 deg-C) is 2:1. Therefore, the reactor should never be filled over half full with liquid at ambient temperature. If operations very close to the 350 deg-C limit are contemplated it would be prudent to reduce the charge to 40% maximum to allow for some overshoot in the temperature control.

5. Pressurized Gas/Vapor

Gas/vapor under pressure represents stored energy. If the pressure containment fails this energy is released as the pressurized gas expands. The energy stored is calculated from:

$$E = \frac{P * V}{k-1}$$

P = pressure
V = volume
k = specific heat
ratio

For the WAO system, k for water vapor is about 1.3 at operating temperature and k for oxygen is about 1.35. From a energy point of view the worst case is assuming all water vapor. For a pressure of 2000 psi and a vapor volume of 1 L, the stored energy is on the order of 34,000 ft-lb, which is the energy equivalent of 10 gms TNT detonating. Stored energy is directly related to vapor volume. If and when the process is scaled-up to pilot or production scale it would be prudent to consider installing the reactors in hardened facilities.

6. Thermal Explosion

Potential hazards in this category relate to an explosive/detonation type reaction of the energetic constituents in the reactor, or thermal runaway oxidation reactions. Raw red water has a reported solids heating value of 3200 Btu/lb (1780 cal/gm) and a solids content of 15% (Ref 1, Table 4). Nitrobodies represent about 55% of the solids (8.25% of the raw red water).

It is unlikely that raw red water could transit to or propagate a detonation reaction given the level of nitrobodies present. The potential for such a reaction in diluted red water is considered non-credible.

The heat of combustion of raw red water is on the order of 480 Btu/lb (3200 Btu/lb-solids X 15% solids). "Instantaneous" oxidation of raw red water, if it occurred, would be a hazard, as the concomitant temperature/pressure excursion assuming typical operating conditions (1000 ml initial charge, 2000-2100 psig, and 320-340 deg-C) would lead to exceeding the pressure/temperature limits of the reactor, and activation of the reactor rupture disc with release of flashing high temperature spray. A "runaway" reaction is probably unlikely; in the absence of chemical reaction pathway and kinetic data, however evaluation of the likelihood or credibility of a runaway is not possible. Therefore, it is recommended that oxidation of undiluted red water not be undertaken until more is known about the reaction pathways and kinetics, and unless evaluation based on that information demonstrates it can be done safely.

Diluting red water reduces the total theoretically available energy input to the system for the same total reactor charge. Modelling studies and mass/energy calculations indicate that a dilution of 10:1 should be sufficient to preclude overpressurization in the event of a runaway reaction. For typical operating conditions, a temperature excursion of 30 deg-F and pressure excursion of 450 psig is predicted. Maximum pressure and temperature under these conditions is within the reactor design envelope and design safety margins. Calculational details are provided in Appendix A. If red water of significantly different solids content or heating value is used, the dilution ratio may have to be adjusted accordingly. A minimum of 20:1 dilution is suggested to provide additional safety margin for unknowns in the variability of these parameters among red water from various sources.

7. Contaminated Surfaces

If red water is allowed to evaporate (e. g., a spill onto the hot reactor), the concentrated solids must be considered as explosive and susceptible to initiation by impact, friction, heat, or electrostatic discharge. Any such spills should be cleaned up using wet methods and not be allowed to dry out.

Another possibility arises if the reactor is operated under conditions which do not achieve good destruction of nitrobodies, or if red waters from other sources contain other energetic species not susceptible to oxidation or which behave differently in the process. As long as these "unknowns" are

not concentrated there is probably no danger. If, however, some unknown should precipitate or accumulate on reactor surfaces, it should be considered potentially dangerous. It should be kept well diluted until identified. Any measures taken to clean reactor surfaces should be done under water or other suitable solvent.

REFERENCES

- 1 Hao, O J and K K Phull, "TNT Red Water Treatment by Wet Air Oxidation," Feasibility Study Report, Contract DACA88-90-M-1418, February 12, 1991
- 2 Clark, A F and J G Hust, "A Review of the Compatibility of Structural Materials with Oxygen," AIAA Journal, Vol 12, No 4, April 1974, 441-454

APPENDIX A

$$\text{Volume: } v_f * L + v_g * G = V \quad \text{Eqn (1)}$$

$$\text{Energy: } h_f * L + h_g * G = E \quad \text{Eqn (2)}$$

$$\text{Mass: } L + G = M \quad \text{Eqn (3)}$$

where:

- v_f = specific volume of liquid water, ft³/lb
- v_g = specific volume of water vapor, ft³/lb
- h_f = enthalpy of liquid water, Btu/lb
- h_g = enthalpy of water vapor, Btu/lb
- L = mass of liquid water, lb
- G = mass of water vapor, lb
- V = volume of reactor, ft³
- E = energy of the system, Btu
- M = total mass of system, lb

Assume the following initial conditions:

$$\begin{aligned} V &= 2 \text{ Liters} = .0706 \text{ ft}^3 \\ L &= 1 \text{ kg} = 2.204 \text{ lb} \\ T &= 625 \text{ deg-F} \end{aligned}$$

$$\begin{aligned} \text{From steam tables, } v_f &= .0250 \text{ ft}^3/\text{lb} \\ v_g &= .2095 \text{ ft}^3/\text{lb} \end{aligned}$$

$$\begin{aligned} h_f &= 654.3 \text{ Btu/lb} \\ h_g &= 1145.8 \text{ Btu/lb} \end{aligned}$$

$$\text{From Eqn (1) calculate } G = .074 \text{ lb}$$

$$\text{Then from Eqn (2) calculate } E = 1526.8, \text{ and from Eqn (3) } M = 2.278 \text{ lb}$$

Take the case of red water diluted 10:1. The heating value is 48 Btu/lb. There are 2.278 lbs of water in the system, or a total heat load of 109.3 Btu. If "instantaneous" adiabatic oxidation occurs, the new system energy is:

$$E = 1526.8 + 109.3 = 1636.1 \text{ Btu}$$

To determine the resultant system temperature and pressure, a trial and error solution on temperature is used. Assume a new temperature, read the specific volume and energies from the steam table and calculate L and G, using Eqns (1) and (2). Then check the value of M using Eqn (3). The correct temperature is that for which the value of M is conserved.

A spreadsheet for doing the trial and error calculations is shown on the next page. The resultant temperature for a 10:1 dilution is about 655 deg-F, with a corresponding water vapor pressure of about 2290 psi.

*T0	625 deg-F	*V0	0.0706 ft3	DILUTION	10 : 1
E0	1527 Btu	*L0	2.2040 lb	RATIO	
*DE	109 Btu	G0	0.0740 lb		
E1	1636 Btu	M0	2.2780 lb		

T	P	vf	vg	hf	hg	G	L	M
625	1852.4	0.0250	0.2095	654.3	1145.8	0.0488	2.4152	2.4640
630	1919.8	0.0253	0.1993	662.2	1141.0	0.0520	2.3813	2.4332
635	1989.0	0.0256	0.1894	670.4	1135.9	0.0556	2.3463	2.4019
640	2060.3	0.0260	0.1799	678.7	1130.7	0.0580	2.3141	2.3721
645	2133.5	0.0264	0.1705	687.3	1124.9	0.0609	2.2809	2.3418
650	2208.8	0.0268	0.1616	696.0	1118.7	0.0641	2.2477	2.3119
655	2286.4	0.0273	0.1529	705.2	1112.2	0.0661	2.2159	2.2820
660	2366.2	0.0278	0.1445	714.4	1104.9	0.0683	2.1846	2.2529
665	2448.0	0.0283	0.1362	724.5	1096.6	0.0717	2.1499	2.2215
670	2532.4	0.0290	0.1281	734.6	1087.9	0.0706	2.1228	2.1933
675	2619.2	0.0297	0.1201	745.5	1078.3	0.0702	2.0931	2.1634
680	2708.4	0.0305	0.1115	757.2	1067.2	0.0685	2.0642	2.1327
685	2800.4	0.0316	0.1032	770.1	1054.6	0.0578	2.0455	2.1032
690	2895.0	0.0328	0.0945	784.2	1039.1	0.0424	2.0302	2.0726
695	2992.7	0.0345	0.0856	801.3	1020.4	0.0037	2.0371	2.0408
700	3094.1	0.0369	0.0758	823.9	995.6	-0.0858	2.0896	2.0037
705	3199.1	0.0440	0.0597	870.2	947.8	-1.0299	3.0020	1.9720
705.	3206.2	0.0541	0.0541	910.3	910.3	ERR	ERR	ERR

* Parameter which is entered to run a particular case

T0 Initial temperature

E0 System energy calculated from initial temperature and composition

DE Energy input from oxidation, based on 480 Btu/lb and dilution

E1 System energy after adiabatic oxidation

V0 Reactor volume

L0 Initial liquid water content of reactor

G0 Reactor water vapor content at initial equilibrium

M0 System total water content

APPENDIX C

**WAO HAZARDS ANALYSIS
(EXCERPTED FROM WAO CONCEPTUAL DESIGN REPORT)**

SECTION 11.0.

OPERATIONS & SAFETY CONSIDERATIONS

11.0. OPERATIONS & SAFETY CONSIDERATIONS

11.1. INTRODUCTION

This section presents a description of special health and safety precautions related to the operations and sampling of a Kenox Wet Air Oxidation system for the treatment of red water.

11.2. REGULATIONS AND GUIDELINES

All activities conducted during the wet air oxidation of red water must be in compliance with applicable requirements of the following publications:

- 29 Code of Federal Regulations (CFR) 1926, Construction Industry, OSHA Safety and Health Standards
- 29 CFR 1910, General Industry OSHA Safety and Health Standards
- 29 CFR 1910.120, OSHA Final Rule dated March 6, 1989, "Hazardous Waste Operations and Emergency Response"
- NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985
- American Conference of Government Industrial Hygienists (ACGIH), "Threshold Limit Values and Biological Exposure Indices", 1989 - 1990, or most current version
- U.S. Department of Health and Human Services, (DHHS) "NIOSH Sampling and Analytical Methods," DHHS (NIOSH) Publication 84-100
- ANSI, Emergency Eyewash and Shower Equipment, Z41.1 (1983)
- ANSI, Protective Footwear, Z358.1 (1981)
- ANSI, Practice for Occupational and Educational Eye and Face Protection, Z87.1 (1968)
- ASTM D4687, Vol. 11.04, Standard Guide for General Planning of Waste Sampling, ASTM, Philadelphia, PA.

11.3. EMERGENCY SHUTDOWN SYSTEM

The prime area of concern is the reaction of the excess oxygen in the reactor system with an inadvertent introduction of an excess of oxidizable chemicals or a material (such as a combination of copper, iron and cobalt) that could act as a catalyst and increase the rate of reaction. The rapid oxidation would result in an increase in the reaction temperature and a corresponding increase in pressure. However, the pressure increase would be mitigated by the pressure control valve PCV-312 opening in response to the pressure surge.

The system is equipped with two levels of alarm. The first alarm, with indication on the CRT, warns of high temperature or high pressure in the system prior to activation of the Emergency Shutdown System.

The second alarm on high temperature or high pressure reading in the reactor system will trigger the Emergency Shutdown System. If the temperature sensor, TSHH-208, on the the reactor system's outlet line senses a temperature over 500 °F (Note: this setting can be changed) or the high pressure sensor, PSHH-313, on the reactor system's outlet line senses a pressure over 1050 psig (resulting from a rapid pressure rise or a malfunction of pressure control valve, PCV-312) , the WAO system will go into automatic shutdown as follows:

1. High temperature alarm is sounded with an indication on the CRT in the control room as to which sensor has activated the shutdown.
2. The microprocessor control unit will automatically initiate the following steps simultaneously:
 - Air to system is stopped by the closing of the emergency shutdown valve XCV-603 located on the outlet line from the air accumulator, D-103.
 - If the electric heater E-102 is in use, a signal will be sent to shut down the heater to prevent any additional heat from being introduced into the system.
 - The waste water feed to the system is stopped by closing of the feed shutdown valve XCV-601 located upstream of the high pressure feed pump, P-103.
 - Service water is introduced to the system by the full opening of the valve XCV-602 located upstream of P-103.

The operator should proceed as follows:

- Acknowledge the alarm.

- Lower the pressure on the system to 900 psig by resetting PCV-312.
- Increase the flow through the high pressure pump, P-103 to 4 USGPM.

All the above steps can be done from the CRT in the control room.

If the pressure and temperature sensors fail to respond or a fault occurs in the control system, then the pressure will be relieved via the safety relief valve PSV-317. A high pressure alarm, PAH-316 would indicate that either the relief valve has been activated or that the rupture disc is leaking. The relief valve will discharge to the atmosphere via a safe location. If the relief valve is activated then the operator should immediately implement the shutdown of the facility via pushing button HS-XXX on the panel or an equivalent icon on the CRT. The rupture disc PSE-314 should be replaced, relief valve settings rechecked and lines between the rupture disc and the safety valve cleaned to remove any residual waste lodged against PSH-316 and PI-315.

11.4. HAZARD ASSESSMENT

11.4.1 Waste Feed

Explosion Potential - Red water has a solids content of 15% and a solids heat content of 3200 BTU/lb. As the initial raw waste stream will be diluted with a recycle effluent stream and a very high reactor recycle stream prior to entering the reactor system (exceeding the 20:1 dilution factor), the effects of temperature and pressure excursions resulting from a detonation type of reaction is negligible. Section 11.3 discusses the Emergency Shutdown System in place to handle temperature and pressure excursions.

Contaminated Surfaces - The raw red water will be pumped to the feed drum from the client's storage tank located outside Kenox' battery limits. In the unlikely event that red water is spilled or leaked, it should be cleaned using wet methods and not be allowed to dry. If it is allowed to dry, the concentrated solids must be considered as explosive and susceptible to initiation by impact, friction, heat or electrostatic charge.

11.4.2 Burn Hazards

All equipment with surface temperatures over 100 deg F have been provided with insulation for personnel protection.

11.4.3 Confined Space Entry

The WAO system shall be evaluated during detailed engineering to determine if any spaces are permit required confined space. A permit required confined space is a space that:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has a potential for engulfing an entrant
- Is configured such that an entrant could be trapped or asphyxiated
- Contains any other safety or health hazard.

A sign reading, "DANGER - PERMIT - REQUIRED CONFINED SPACE, DO NOT ENTER" will be posted at the entrance to any confined space.

11.4.4 Sampling

Red water may present potential inhalation and skin contact hazards during the sampling and sample handling activities. Appropriate personal protective equipment should be worn (i.e. safety glasses, hand protection, apron). Material Safety Data Sheets on some major components of red water are presented in Section 11.4.5.

SECTION 11.4.5.

MATERIAL SAFETY DATA SHEETS

* M S D S *
*
* Canadian Centre for Occupational Health and Safety *

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 347777
PRODUCT NAME(S) : TNT
PRODUCT IDENTIFICATION : EXP 0032

*** MANUFACTURER INFORMATION ***

MANUFACTURER : ICI Canada Inc
ADDRESS : 90 Sheppard Avenue East
Box 200 Station "A"
North York Ontario
Canada M2N 6H2
Telephone: 416-229-7000
Telex: 06986505
Fax: 416-229-7752
EMERGENCY TELEPHONE NO. : 800-561-3636

*** MATERIAL SAFETY DATA ***

ICI Canada Inc.
P.O. Box 200, Station "A"
North York, Ontario
Canada, M2N 6H2

TNT

MATERIAL SAFETY DATA SHEET

Date Issued: 91 06 06

Index: EXP 0032/91B

FOR EMERGENCIES INVOLVING CHEMICAL SPILL OR RELEASE, CALL THE ICI CANADA
TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-800-561-3636.

PRODUCT IDENTIFICATION

Product Name: TNT
Chemical Name: 2,4,6-Trinitrotoluene
Synonyms: Methyltrinitrobenzene, alpha-TNT, Nitropel, TNT (TY1 Flake)
(Military Grade), TNT (Flake), Triton, Trinitrotoluol, Trotyl, Tolite,
Trinitrotoluene.
Chemical Family: High Explosives.
Molecular Formula: (NO2)3C6H2CH3
Product Use: Blasting agent. Manufacture of packaged explosives and primers
(cast explosive).

REGULATORY SECTION

Controlled Products Regulations Classification: This product is an explosive and is not regulated by WHMIS.

OSHA Hazard Communication (29CFR 1910.1200) Classification: Irritant (eye, skin and respiratory tract); skin sensitizer; explosive.

CANADIAN TDG ACT SHIPPING DESCRIPTION

Shipping Name: Trinitrotoluene (or TNT)
Shipping Class/Division: 1.1D
Product Identification No (PIN): UN0209
Packing Group: II

U.S. DOT Classification: Refer to the "Code of Federal Regulations."

Other Regulations: Not available.

Read the entire MSDS for the complete hazard evaluation of this product.

HAZARDOUS INGREDIENTS OF PRODUCT

Hazardous Ingredients	%(w/w)	ACGIH TLV	CAS No.
Trinitrotoluene	98-100	0.5 mg/m3	118-96-7

PHYSICAL PROPERTIES

Physical State: Solid.
Appearance and Odour: Pale yellow flakes or prills; practically odourless.
Odour Threshold: Not applicable.
Boiling Range (Deg. C): Decomposes at 270.
Melting/Freezing Point (Deg. C): 80.65 (pure TNT)
Vapour Pressure: 0.053 mmHg (@ 85 Deg. C).
Specific Gravity: 1.645 (crystals); 1.47 (molten) (water = 1).
Vapour Density: Not available.
Bulk Density: 0.94 g/cc
Evaporation Rate: Not applicable.
Solubility: 0.013 g/100 g of water at 20 Deg. C. Sparingly soluble in alcohol; soluble in benzene, toluene and acetone.
% Volatile by Volume: Not applicable.
pH: Not applicable.
Coefficient of Water/Oil Distribution: Not available.
Sensitivity to Mechanical Impact: One of the least sensitive of the high explosives. More sensitive in the liquid form than the solid.
Rate of Burning: Not available.
Explosive Power: 439 kJ/100 g
Sensitivity to Static Discharge: Not available.

REACTIVITY DATA

Stability:

Under Normal Conditions: Stable.

Under Fire Conditions: Flammable.

Hazardous Polymerization: Will not occur.

Conditions to Avoid: Excessive heat, situations where product may be

confined, and prolonged exposure to sunlight.

Materials to Avoid: Strong oxidizers and reducing agents, alkaline materials and mineral acids.

Hazardous Decomposition or Combustion Products: When heated to decomposition, it emits toxic nitrogen oxide (NOx) fumes. Its combustion products include large amounts of black smoke and nitrogen oxide fumes (NOx).

FIRE AND EXPLOSION DATA

Flash Point (Deg. C) (Method): Not available.

Autoignition Temperature: Approx. 295-330 Deg. C.

Flammability Limits in Air (%): LEL: Not applicable.

UEL: Not applicable.

Fire Extinguishing Media: See below.

Fire Fighting Procedures: DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area.

Other Fire or Explosion Hazards: Not applicable.

TOXICOLOGICAL AND HEALTH DATA

Recommended Exposure Limit: See "HAZARDOUS INGREDIENTS OF PRODUCT" Section.

Toxicological Data:

Trinitrotoluene LD50 (oral, rat) = 795 mg/kg (1)

Carcinogenicity Data: The ingredient(s) of this product is (are) not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by NTP (National Toxicology Program).

Reproductive Effects: No information is available and no adverse reproductive effects are anticipated.

Mutagenicity Data: No information is available and no adverse mutagenic effects are anticipated.

Teratogenicity/Fetotoxicity Data: No information is available and no adverse teratogenic/embryotoxic effects are anticipated.

Synergistic Materials: None known.

EFFECTS OF EXPOSURE WHEN:

. Inhaled: Product is irritating to the nose, throat and respiratory tract. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

. In contact with the skin: This product may cause irritation due to

abrasive action. Prolonged and repeated contact may lead to dermatitis. May be absorbed through intact skin. May cause skin sensitization or other allergic responses. See "Other Health Effects" Section.

. In contact with the eyes: This product causes irritation, redness and pain. Prolonged and repeated contact may cause cataracts.

. Ingested: Ingestion of large amounts may cause nausea, gastrointestinal upset and abdominal pain. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

Other Health Effects: Initial manifestation of methemoglobinemia is cyanosis, characterized by navy blue, almost black lips, tongue, and mucous membranes, with skin colour being slate gray. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia.

Signs and symptoms of kidney damage generally progress from oliguria, to blood in the urine, to total renal failure.

If ingested, Nitrates may be reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include cyanosis (due to methemoglobin formation), nausea, dizziness and increased heart rate.

CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure.

Sensitization is the process whereby a biological change occurs in the individual because of previous exposure to a substance and, as a result, the individual reacts more strongly when subsequently exposed to the substance. Once sensitized, an individual can react to extremely low airborne levels, even below the TLV, or to skin contact.

FIRST AID PROCEDURES WHEN:

. Inhaled: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical attention IMMEDIATELY.

. In contact with the skin: Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

. In contact with the eyes: Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

. Ingested: If victim is alert and not convulsing, rinse mouth out and give 1/2 to 1 glass of water to dilute material. DO NOT induce vomiting. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. Obtain medical attention IMMEDIATELY.

Emergency Medical Care: Alcohol use may cause enhanced response to effects

of TNT exposure. Individuals deficient in glucose-6-phosphate dehydrogenase may be at greater risk. Medical conditions that may be aggravated by exposure to this product include cardiovascular diseases and liver, blood and kidney disorders.

PREVENTATIVE MEASURES

Recommendations listed in this section indicate the type of equipment which will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

Engineering Controls: Local exhaust ventilation required, if the product itself is handled.

Respiratory Protection: A NIOSH/MSHA-approved air-purifying respirator equipped with combined dust, mist, fume/organic vapour cartridges for concentrations up to 5 mg/m³ TNT. An air-supplied respirator if concentrations are higher or unknown.

Skin Protection: Gloves and protective clothing made from cotton should be impervious under conditions of use. The use of coveralls is recommended.

Eye Protection: Safety glasses with side shields are recommended to prevent eye contact.

Other Personal Protective Equipment: Locate safety shower and eyewash station close to chemical handling area.

Handling Procedures and Equipment: This product is an explosive and should only be used under the supervision of an experienced blaster.

Storage Temperature (Deg. C): See below.

Storage Requirements: Dry, secure magazine that is properly grounded. Do not expose to temperatures above 35 Deg. C.

Other Precautions: Use only with adequate ventilation and avoid breathing dusts/vapours. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Wash contaminated clothing thoroughly before re-use.

ENVIRONMENTAL PROTECTION DATA

Steps to be Taken in the Event of a Spill or Leak: Stop and contain spill. Wet spilled material and sweep up into strong plastic bags or plastic containers. Keep the material wet. Avoid use of metal tools. Be careful to avoid shock, friction and sparks. Notify applicable government authority if release is reportable or could adversely affect the environment.

Environmental Effects: Harmful to aquatic life at low concentrations. A concentration of 1.5 mg/L is toxic to fish. Can be dangerous if allowed to enter drinking water intakes. Product has an unaesthetic appearance and can be a nuisance.

Deactivating Chemicals: None known.

Waste Disposal Methods: Do not dispose of waste with normal garbage, or to sewer systems. Burn under supervision of an expert at a government-approved explosive burning ground or destroy, by detonation in boreholes, with explosives in accordance with applicable local, provincial and federal regulations. Call upon the services of an ICI Technical Representative.

ADDITIONAL INFORMATION AND SOURCES USED

1. RTECS-Registry of Toxic Effects of Chemical Substances, On-line search, Canadian Centre for Occupational Health and Safety RTECS database, Vol I-V, 1985-1986 edition, Doris V. Sweet, Ed., National Institute for Occupational Safety and Health, U.S. Dept. of Health and Human Services, Cincinnati, 1987.
 2. U.S. Dept. of Health and Human Services, NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, NIOSH, U.S. Dept. of Labour, 1978.
 3. Explosives, R. Meyer, 2nd Edition, 1981, Verlag Chemie.
 4. M.W. Nay et al, J. Wat. Pollut. Control Fed., 1974, Volume 46, 485-497.
 5. Formula Book - Explosives, C-I-L Inc., Explosives, Research and Technical Department, current Edition.
 6. Chemistry and Technology of Explosives, Vol. 1, T. Vrbanski, Pergamon Press, 1983.
 7. Windholz, Martha, Ed., The Merck Index, 10th ed., Merck and Co. Inc., Rahway, New Jersey, 1983.
 8. Sax, N. Irving, Dangerous Properties of Industrial Materials, 7th ed., Van Nostrand Reinhold Co., New York, 1989.
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The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and ICI Canada Inc. will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

Date Issued: 91 06 06
Date Revised: 91 06 06
MSDS Index No: EXP 0032/91B

Prepared By: Safety, Health and Environment (416) 229-8252

* M S D S *
*
* Canadian Centre for Occupational Health and Safety *

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 690925
PRODUCT NAME(S) : DNT Mixture
Dinitrotoluene Mixture
PRODUCT IDENTIFICATION : MSDS NUMBER: CEC00012
DATE OF MSDS : 1992-11-07

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
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*** MATERIAL SAFETY DATA ***

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Material Safety Data Sheet

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Dinitrotoluene Mixture
CEC00012 Revised 7-NOV-1992 Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

CAS Number : 25321-14-6
Formula : CH3C6H3(NO2)2
CAS Name : Benzene, methyl dinitro
Grade : Technical

Tradenames and Synonyms

DNT Mixture

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont Canada, Inc.
P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
*2,4-Dinitrotoluene	121-14-2	76
*2,6-Dinitrotoluene	606-20-2	19
Other Mono/Di/Tri-nitrotoluene isomers		5

* Regulated as a Toxic Chemical under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful if inhaled or absorbed through skin; causes cyanosis. Symptoms may be delayed. Causes irritation.

Inhalation 1-hour LC50: >2.87 mg/l in rats - Data is
Skin absorption ALD: >1,000 mg/kg in rabbits for
Oral LD50: 177 mg/kg in rats 2,4-DNT

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Material Safety Data Sheet

(HAZARDS IDENTIFICATION - Continued)

2,4-DNT is an eye and skin irritant. Toxic effects described in animals from short exposures include nonspecific effects such as reduced weight gain, methemoglobinemia and effects on the central nervous system, the reproductive system, and the bone marrow. In tests with laboratory animals, technical grade 2,4-DNT has carcinogenic activity. Tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive, with positive results in some studies, and negative results in others. Tests in animals demonstrate no developmental activity. 2,4-DNT produce testicular degeneration and decreased spermatogenesis in rats, mice, and dogs. Reduction in male fertility occurs in dominant lethal studies in rats.

2,6-DNT is a skin irritant, is not an eye irritant, and is a skin sensitizer in tests with laboratory animals. Toxic effects described in animals from exposure include methemoglobinemia, decreased spermatogenesis, testicular atrophy, anemia, paralysis and tremors. Tests with 2,6-DNT in some animals demonstrate carcinogenic activity, while tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive with positive results in some studies, and negative results in others.

Human health effects of overexposure may initially include: reduction of the blood's oxygen carrying capacity with cyanosis (bluish discoloration), weakness, or shortness of breath by methemoglobin formation; abnormal blood forming system function with anemia; red blood cell destruction; nonspecific discomfort, such as nausea, headache or weakness; temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness; temporary lung irritation effects with cough, discomfort, difficulty breathing, or shortness of breath; or joint pain. All isomers appear to be able to significantly permeate the skin. There are no reports of human sensitization. Individuals with preexisting diseases of the cardiovascular system or bone marrow may have increases susceptibility to the toxicity of excessive exposures.

Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens. A "P" indicates a proposed carcinogen.

Material	IARC	NTP	OSHA	ACGIH
Dinitrotoluene Mixture				X
2,4-Dinitrotoluene				X

Du Pont controls the following materials as potential carcinogens:
2,4-Dinitrotoluene.

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FIRST AID MEASURES

First Aid

In case of contact: Immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse and destroy contaminated shoes.

If inhaled: Remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician.

If swallowed: Induce vomiting immediately by giving two glasses of water and sticking finger down throat. Call a

physician. Never give anything by mouth to an unconscious person.

Note to Physician: Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. In case of skin absorption, symptoms may be delayed. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. If cyanosis is severe, intravenous injection of methylene blue, 1 mg/kg body weight, may be of value. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point	: 173 C (343 F)
Method	: SFCC
Flammable limits in Air, % by Volume	
LEL	: *
UEL	: *
Autoignition	: * C
Autodecomposition	: 270 C (518 F)

*Not available

Fire and Explosion Hazards:

OSHA Class III B Combustible Material. Will burn. Fire or high temp., above 270 C (518 F), and confined material will cause an explosion (see also Decomposition).

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Material Safety Data Sheet

(FIRE FIGHTING MEASURES - Continued)

Extinguishing Media

Water, Dry Chemical.

Carbon dioxide (CO2)

Fire Fighting Instructions

Evacuate personnel to a safe area. Flood with water. Cool tank/container with water spray.

Do not attempt to fight large or advanced fires; material will explode if confined and heated above 270 C. Fight smaller fires with unmanned or remotely activated equipment. Run-off from fire control may cause pollution.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Evacuate area - admission should be limited to trained personnel wearing full protective equipment. If molten, dike, soak up with sand or other non-combustible absorbant and allow to freeze. Place solid material in a covered steel drum for disposal. Use non-sparking tools. Comply with Federal, State, and local regulations on reporting releases.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe vapor or mist. Do not breathe dust. Do not get on skin. Do not get on clothing. Do not get in eyes. Wash thoroughly after handling.

Use only with adequate ventilation.

Storage

Store in a well ventilated place.

Keep away from heat, sparks, and flame. Keep drums upright and tightly closed.

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EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use in a totally closed system. Ventilation should be provided to keep concentration below the exposure limits.

Personal Protective Equipment

Eye/Face	: Coverall chemical splash goggles. Safety glasses (side shields); full-length face shield.
Respirator	: Air supplied respirator. Suitable respiratory protection & chem. proof suit w/hood.
Additional	: Butyl rubber apron and footwear

Protective Gloves: Neoprene or butyl gauntlet- lined if
handling hot material.

Exposure Guidelines

Exposure Limits

Dinitrotoluene Mixture

PEL (OSHA)	: 1.5 mg/m ³ , 8 Hr. TWA, Skin
TLV (ACGIH)	: 0.15 mg/m ³ , 8 Hr. TWA, A2, Skin
AEL * (Du Pont)	: None Established

Other Applicable Exposure Limits

2,4-Dinitrotoluene

PEL (OSHA)	: 1.5 mg/m ³ , 8 Hr. TWA, Skin
TLV (ACGIH)	: 1.5 mg/m ³ , 8-Hr. TWA, Skin
	Notice of Intended Changes (1993-1994)
	0.15 mg/m ³ , 8 Hr. TWA, A2, Skin
AEL * (Du Pont)	: 0.15 mg/m ³ , 8 & 12 Hr. TWA, Skin
	<5% 2,6-DNT

2,6-Dinitrotoluene

PEL (OSHA)	: 1.5 mg/m ³ , 8 Hr. TWA, Skin
TLV (ACGIH)	: 0.15 mg/m ³ , 8 Hr. TWA, A2, Skin
AEL * (Du Pont)	: None Established

* AEL is Du Pont's Acceptable Exposure Limit. Where
governmentally imposed occupational exposure limits which are
lower than the AEL are in effect, such limits shall take
precedence.

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Material Safety Data Sheet

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PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Vapor Pressure	: <1 mm/Hg @ 100 C (212 F)
Vapor Density	: 6.3 (Air = 1)
Evaporation Rate	: <1 0
Solubility in Water	: <1 WT%
	@ 22 C (72 F)
Odor	: Distinctive Nitro Aromat.
Form	: Solid/Molten
Color	: Medium Yellow
Specific Gravity	: 1.32 @ 57C

pH Information: Not available

Appearance: Crystalline/Clear Oil

Boiling Point, 760 mmHg: Starts decomposing at 250 C (482 F)

Freezing Point: 56 C (133 F) dry basis

STABILITY AND REACTIVITY

Incompatibility with Other Materials

Incompatible with strong oxidizers and caustics.

Polymerization

Polymerization will not occur.

Other Hazards

Instability: Unstable above 250 C (482 F). Will explode if confined and heated above 270 C (518 F).

Decomposition: May release hazardous Nitrogen Oxide (Nox) gases. Solid DNT is more sensitive to decomposition than liquid DNT. Contamination by foreign material, especially gritty substances, may considerably lower the decomposition temperature and increase the sensitivity of DNT to decomposition and explosion.

TOXICOLOGICAL INFORMATION

No Information Available

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ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

The product is moderately toxic (96-hr LC50 = 1 - 50 mg/l).

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, may be incinerated using special techniques, or removed to hazardous material landfill licensed for carcinogenic materials.

TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name : Dinitrotoluene, Solid; Dinitrotoluene,
Molten
Hazard Class : ORM-E

I.D. No. (UN/NA) : Solid = 2038; Molten = 1600

DOT/IMO
Proper Shipping Name : Dinitrotoluenes, Solid; Dinitrotoluenes,
Molten

Hazard Class : Poison B, 6.1

UN No. : Solid = 2038; Molten = 1600

DOT/IMO Label : Poison

Special Information : Flash Point: 173 C

Packing Group : II

Reportable Quantity : 1000 lb

Shipping Containers
T/cars, T/trucks, steel drums

Shipping Information -- Canada

TDG
Proper Shipping Name : DINITROTOLUENE SOLID

PIN No. : UN 2038

TDG Class : 6.1 (9.2)

TDG Packing Group : II

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Material Safety Data Sheet

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REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision A - Very Toxic Material.
Carcinogen, Reproductive Toxin.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye
Irritant, Skin Sensitizer.

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating

Health : 2

Flammability : 1

Reactivity : 1

Personal Protection rating to be supplied by user depending on use
conditions.

Additional Information

For further information, see "Dinitrotoluene Mixture"
Data Sheet.

Title III Classifications:

Acute Health	-	Yes
Chronic Health	-	Yes
Fire Hazard	-	No
Reactivity	-	Yes
Pressure	-	Yes

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS
Address : MISSISSAUGA, ONTARIO
Telephone : 416-821-3300

Indicates updated section.

End of MSDS

M S D S

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 691088
PRODUCT NAME(S) : Sodium Nitrite Solution
PRODUCT IDENTIFICATION : MSDS NUMBER: CEC00191
DATE OF MSDS : 1993-10-28

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

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Sodium Nitrite Solution
CEC00191 Revised 28-OCT-1993 Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

Corporate MSDS Number : DU002807
Formula : NaNO_2 (in water)
CAS Name : NITROUS ACID, SODIUM SALT
Grade : TECHNICAL; OXIDIZING SALT SOLUTION

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Canada, Inc.

P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
TECHNICAL GRADE:		
SODIUM NITRITE	7632-00-0	41
WATER	7732-18-5	59
OXIDIZING SALT SOLUTION:		
SODIUM NITRITE	7632-00-0	40
SODIUM CARBONATE	497-19-8	2
SODIUM NITRATE	7631-99-4	10
WATER	7732-18-5	48

DSL: REPORTED/INCLUDED

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful or fatal if swallowed. Harmful if inhaled.
Overexposure by inhalation or ingestion may cause reduced oxygen carrying capacity of blood. Causes skin and eye irritation.

HUMAN HEALTH EFFECTS:

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(HAZARDS IDENTIFICATION - Continued)

Human health effects of overexposure to the product by skin or eye contact may include skin irritation with discomfort or rash; or eye irritation with discomfort, tearing, or blurring of vision. Sodium nitrite has been infrequently associated with skin sensitization in humans. By inhalation, irritation of the upper respiratory passages with coughing may occur. By inhalation or ingestion, the effects may include low blood pressure with headache and fainting, or nonspecific discomfort such as nausea or weakness. Overexposure may also cause methemoglobinemia (reduced oxygen carrying capacity of the blood) with cyanosis (bluish discoloration of the skin), possibly progressing to dizziness, incoordination, shortness of breath, increased pulse rate, and loss of consciousness.

Sodium nitrite can also react with certain amines forming compounds which may cause cancer, mutations, or other toxicity. These compounds, known as nitrosamines, can be formed in acidic environments such as that found in the stomach. Since many medications and chemicals contain an amine group, simultaneous exposure to nitrites should be avoided.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing. Call a physician. Wash clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, immediately give two glasses of water and induce vomiting. Call a physician. Never give anything by mouth to an unconscious person.

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DuPont

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Material Safety Data Sheet

(FIRST AID MEASURES - Continued)

Notes to Physicians

Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need to be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Autodecomposition : 490 C (914 F) after drydown

Will not burn.

Fire and Explosion Hazards:

Strong oxidizer when water is removed. Combustible materials may catch fire more easily after being wet with sodium nitrite and dried. Product intensifies combustion of other materials. Fires are difficult to extinguish. See "Decomposition".

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Flood with water.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

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Material Safety Data Sheet

(ACCIDENTAL RELEASE MEASURES - Continued)

Accidental Release Measures

Flush spill area with plenty of water. Comply with Federal, State, and local regulations on reporting releases. The Superfund reportable discharge for sodium nitrite is 100 lbs.

HANDLING AND STORAGE

Handling (Personnel)

Do not take internally. Keep from contact with clothing and other combustible materials. Avoid contact with eyes and skin. Avoid breathing vapors or mist. Avoid breathing dust from dried-down product. Wash thoroughly after handling.

Storage

Do not store with acids, ammonium salts, cyanides, amines or reducing agents.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Good general ventilation should be provided to minimize contact with vapors, or dust from dried-down product.

Personal Protective Equipment

Eye/Face : Coverall chemical splash goggles.
Protective Gloves : Rubber gloves.

If product is allowed to dry and dusty conditions exist, use NIOSH/MSHA approved respiratory protection.

Exposure Guidelines

Applicable Exposure Limits

SODIUM NITRITE

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (Du Pont) : 2 mg/m³, 8 Hr. TWA, respirable dust
WEEL (AIHA) : None Established

SODIUM NITRITE

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Material Safety Data Sheet

(Continued)

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (Du Pont) : 2 mg/m³, 8 Hr. TWA, respirable dust
WEEL (AIHA) : None Established

SODIUM CARBONATE

PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (Du Pont) : 5 mg/m³, 8 Hr. TWA

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water : 100 WT% Technical and Oxidizing Salt Solution
Odor : Odorless
Form : Clear liquid

	Technical	Oxidizing Salt Solution
Color	Pale Yellow	Straw Colored
Boiling Pt., 760 mmHg	115 deg C (239 deg F)	114.5 deg C (238 deg F)
Freezing Point	-1 deg C (30 deg F)	~10-20 deg C (50-68 deg F)
Specific Gravity	1.32 at 16 deg C (60 deg F)	~1.4/16 deg C (34/60 deg F)
Vapor Pressure at 25 deg C 38 deg C	17 mmHg 35 mmHg	~50 mmHg ~90 mmHg
Vapor Density (Air=1)	Less than 1	Less than 1
pH Information	8.9	9
Evaporation Rate	Greater than 1	Greater than 1

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STABILITY AND REACTIVITY

Chemical Stability

Unstable with heat after dry down.

Decomposition

Decomposes with heat.

Decomposition temperature is 490 deg C (914 deg F) after drydown to produce oxygen and toxic nitrogen gases.

Polymerization

Polymerization will not occur.

Other Hazards

Incompatibility : Incompatible with acids, ammonium salts, amines, activated carbon, cyanides, and reducing agents. May react with secondary or tertiary amines to form nitrosamines (Certain nitrosamines are cancer-suspect agents.).

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

96-hour LC50, minnows: >100 mg/L

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, flush to waste treatment system.

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TRANSPORTATION INFORMATION

Shipping Information

DOT
Proper Shipping Name : Hazardous Substance, Liquid, N.O.S.*
Hazard Class : ORM-E
I.D. No. (UN/NA) : NA No: 9188
DOT Label(s) : None
Special Information : *Not regulated in packages containing less than 300 lbs.
DOT Placard : None

DOT/IMO
Proper Shipping Name : Not regulated as a hazardous material.
Hazard Class : Not regulated.

Reportable Quantity : 100 lb

Shipping Containers

T/C, T/T, sample bottles

Shipping Information -- Canada

TDG
Proper Shipping Name : OXIDIZING SUBSTANCES N.O.S. LIQUID
(SODIUM NITRITE, SODIUM NITRATE, SODIUM CARBONATE)
PIN No. : UN 1479
TDG Class : 5.1, (9.2)
TDG Packing Group : II

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS C Oxidizing Material

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye Irritant.

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OTHER INFORMATION

Additional Information

Title III Classifications:

Acute Health - Yes
Chronic Health - Yes
Fire Hazard - No
Reactivity - No
Pressure - No

For further information, see Du Pont's "Sodium Nitrite" Data Sheet.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS
Address : MISSISSAUGA, ONTARIO
Telephone : 416-821-3300

Indicates updated section.

End of MSDS

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 756024
PRODUCT NAME(S) : SODIUM NITRATE
PRODUCT IDENTIFICATION : 06SDNA
DATE OF MSDS : 1994-06-09

*** MANUFACTURER INFORMATION ***

MANUFACTURER : GRACE DEARBORN INC
ADDRESS : 3451 ERINDALE STATION ROAD
MISSISSAUGA ONTARIO
CANADA L5C 2S9
EMERGENCY TELEPHONE NO. : 905-279-2222 (OFFICE HOURS)
613-996-6666 (AFTER HOURS)

*** MATERIAL SAFETY DATA ***

Page 1 Version #: 3.00
MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

=====

1) PRODUCT IDENTIFICATION: SODIUM NITRATE

PRODUCT USE: COMMODITY CHEMICAL

MANUFACTURER:
GRACE DEARBORN INC.
3451 ERINDALE STATION ROAD
MISSISSAUGA, ONTARIO
L5C 2S9

EMERGENCY PHONE:

OFFICE HOURS: 905-279-2222
AFTER HOURS: 613-996-6666

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:
SODIUM NITRATE 5.1 UN1498 III
WHMIS CLASSIFICATION:
CLASS C: CLASS D DIVISION 2 SUBDIVISION B

=====

2) INGREDIENTS:

Chemical Name.	CAS #	TLV(mg/m3)	LD50(mg/Kg)
SODIUM NITRATE	7631-99-4	N/E	2000C
	%RANGE-(60.0- 100.0)		

=====

3) PHYSICAL DATA:

Physical state..... SOLID
Odour threshold..... N/D
Specific gravity..... 1.28
Density..... N/D
pH..... 1% = 7 - 8
Solubility in water.. 73
Appearance and odour..

Freezing point.(Deg.C)N/A
Boiling point..(Deg.C)N/A
Vapour pressure.....N/A
Vapour density(air=1).N/A
Evaporation rate.....N/A
Coeff. of water/oil...N/D

WHITE PELLETS, ODOURLESS

=====

4) FIRE AND EXPLOSION HAZARD DATA:

CONDITIONS OF FLAMMABILITY:

NON-FLAMMABLE

EXTINGUISHING MEDIA:

WATER X

FOAM X

CO2 X

Other : DRY CHEMICAL

SPECIAL PROCEDURES:

TREAT AS A CLASS A FIRE.

MODERATE WHEN MIXED WITH ORGANIC MATTER - EXPLODES WHEN
HEATED OVER 1000 DEGREES C - OXIDIZING AGENTS.

FLASH POINT: (Deg. C FMCC) NONE

FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D UPPER N/D

AUTO IGNITION TEMP: (Deg. C) N/D

HAZARDOUS COMBUSTION PRODUCTS: N/D

EXPLOSION DATA:

SENSITIVITY TO IMPACT..... :NONE KNOWN

SENSITIVITY TO STATIC DISCHARGES...:NONE KNOWN

=====

MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

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5) REACTIVITY DATA:

STABILITY (NORMAL COND.) STABLE X UNSTABLE

CONDITIONS TO AVOID:

AVOID EXTREME HEAT ABOVE 1000 DEGREES C

CONDITIONS OF REACTIVITY:

N/D

INCOMPATIBILITY: (MATERIALS TO AVOID)

ORGANIC MATERIALS

HAZARDOUS DECOMPOSITION PRODUCTS:

N/D

=====

6) TOXICOLOGICAL PROPERTIES:

ROUTE OF ENTRY: SKIN CONTACT X ABSORBED BY SKIN EYE CONTACT X

INHALATION X INGESTION X

EFFECTS OF ACUTE EXPOSURE

MAY CAUSE IRRITATION TO SKIN AND EYES. AVOID PROLONGED AND/
OR REPEATED CONTACT.

MAY CAUSE DISCOMFORT, NAUSEA OR VOMITING IF INGESTED.

MAY CAUSE IRRITATION TO UPPER RESPIRATORY TRACT IF INHALED.

EFFECTS OF CHRONIC EXPOSURE:

N/D

Oral rat LD50mg/Kg.(calc.):>2000

Exposure limits..... :N/D

Irritancy..... :N/D

Sensitization.....:N/D

Synergistic Mat..... :NONE KNOWN

Carcinogenicity..... :NONE KNOWN

Reproductive Eff..... :NONE KNOWN

Teratogenicity..... :NONE KNOWN

Mutagenicity..... :NONE KNOWN

=====

7) PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT:

EYE PROTECTION:X

GLOVES:X

CLOTHING:X

RESPIRATORY PROTECTION:

DUST MASK

VENTILATION REQUIREMENTS:

MECHANICAL (GENERAL)

SPILL AND LEAK PROCEDURES:

PICK UP DRY SPILLS AND RETURN TO CONTAINER. FLUSH

REMAINDER TO DRAIN WITH EXCESS WATER.

WASTE DISPOSAL:

USE AN APPROVED SCAVENGER SERVICE.

HANDLING PROCEDURES:

WEAR CHEMICAL GOGGLES AND RUBBER GLOVES.

USE PERSONAL PROTECTIVE CLOTHING.

STORAGE REQUIREMENTS:

STORE AWAY FROM ORGANICS IN DRY FIREPROOF BINS.

WOOD AND PAPER BAGS SATURATED WITH SODIUM NITRATE SHOULD

BE REMOVED FROM PREMISES.

SPECIAL HANDLING INFORMATION:

NONE

=====

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MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

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8) FIRST AID MEASURES:

WASH CONTAMINATED AREA THOROUGHLY WITH SOAP AND WATER. LAUNDRY CLOTHING BEFORE REUSE. FLUSH EYES WITH FLOWING WATER FOR 15 MINUTES AND GET MEDICAL ATTENTION. IF INGESTED, INDUCE VOMITING AND GIVE LARGE QUANTITIES OF WATER AND GET MEDICAL ATTENTION IMMEDIATELY. GASTRIC LAVAGE MAY BE REQUIRED.

=====

9) OTHER INFORMATION:

NONE

=====

10) PREPARATION INFORMATION

PREPARED BY: T.R.Erwin.

GRACE DEARBORN INC.

P.O. BOX 3060 STATION A.

MISSISSAUGA ONTARIO. L5A 3T5

N/D-No Data N/A-Not Applicable N/E-Not Established <-Less >-Greater

A=Oral rat LD50 B=Oral rat LD low C=oral LD50/LD low other animal

D=Estimated 1000 E=Arbitrary 2000 F=Other Route Prefix C=Ceiling limit

=====

APPENDIX D

**CBC HAZARDS ANALYSIS
(EXCERPTED FROM CBC CONCEPTUAL DESIGN REPORT)**

CONCEPTUAL DESIGN AND RELATED DOCUMENTS

15.0 OPERATIONS AND SAFETY CONSIDERATIONS

U.S. Army Environmental Center
Red Water Treatment Technology
Test Plan and Site Preparation
Aberdeen Proving Ground, Maryland

KNJ585WP158501-12-95D11NE1

15.0 Operations and Safety Considerations

15.1 Introduction

The protection of workers and environmental health and safety (H&S) are major concerns during project implementation and cannot be compromised. This document presents a description of special H&S precautions related to operating and sampling a CBC for the destruction of red water for USAEC. This document is not intended to serve as the site health and safety plan (HASP).

15.2 Regulations and Guidelines

All activities conducted during the incineration of red water must be in compliance with applicable requirements of the following publications:

- 29 Code of Federal Regulations (CFR) 1926, Construction Industry, Occupational Safety and Health Administration (OSHA) Safety and Health Standards
- 29 CFR 1910, General Industry OSHA Safety and Health Standards
- 29 CFR 1910.120, OSHA Final Rule dated March 6, 1989, "Hazardous Waste Operations and Emergency Response"
- National Institute of Occupational Safety and Health (NIOSH)/OSHA/USCG/U.S. Environmental Protection Agency (EPA), "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985
- American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values and Biological Exposure Indices," 1989-1990, or most current version
- U.S. Department of Health and Human Services (DHHS), "NIOSH Sampling and Analytical Methods," DHHS (NIOSH) Publication 84-100
- American National Standards Institute (ANSI), Practice for Respiratory Protection, Z88.2, 1980
- ANSI, Emergency Eyewash and Shower Equipment, Z41.1, 1983
- ANSI, Protective Footwear, Z358.1, 1981

- ANSI Physical Qualifications for Respirator Use, Z88.6, 1984
- ANSI, Practice for Occupational and Educational Eye and Face Protection, Z87.1, 1968.

15.3 Hazard Assessment

This section discusses the hazards that are anticipated to be encountered during operation of the CBC to burn red water. The potential hazards associated with operation of the CBC include chemical and physical hazards.

15.3.1 Chemical Hazards

Potential exists for personnel to come into contact with the following types of materials:

- Reactive and toxic feed materials
- Flammable solvents used in the sampling trains
- Toxic and corrosive combustion products.

15.3.1.1 Feed Materials

The feed materials during routine operations is red water. Red water is the aqueous effluent generated during sellite purification of crude TNT. The characteristics of red water are presented at the end of this chapter.

Explosion Potential. The red water has a solids heat content of 3,200 Btu/lb. The solids are in a solution that is 85 percent water, which makes the red water endothermic.

CBCs were originally designed to manage materials with high heat content for energy production. The level of energy in the red water will not be dangerous for the CBC. Additionally, the large internal volume of the CBC will dissipate any pressure shocks that could occur from uneven combustion of the red water.

Contaminated Surfaces. The red water will be pumped directly to the CBC feed port. In the unlikely event that red water is spilled, it should be cleaned up using wet methods and not allowed to dry. Dry TNT or related materials can explode due to friction or spark.

15.3.1.2 Ash

The ash from the CBC will be a fine particulate that may be toxic. It is unlikely that explosive materials will be found in the ash to present a physical or chemical hazard. Toxicity of the ash will be due to the presence of metals. The fine particulate will be a respiratory hazard.

Respiratory Protection. The following rules will be adhered to by all site personnel when respiratory protection is in use:

- Only properly cleaned, maintained, NIOSH/Mine Safety and Health Administration (MSHA)-approved respirators will be used on site.
- Selection of respirators, as well as any decisions regarding upgrading or downgrading of respiratory protection, will be made by the site H&S officer upon consultation with a senior health and safety professional.
- Used air-purifying cartridges will be replaced at the end of each shift or when load-up or breakthrough occurs.
- Only employees who have had pre-issued qualitative fit tests and annual fit tests thereafter will be allowed to work in atmospheres where respirators are required.
- If an employee has demonstrated difficulty in breathing during the fit test or during use, he/she will be given a physical examination to determine whether a respirator can be worn while performing the required duty.
- No employee will be assigned tasks requiring the use of respirators, if based upon the most recent examination, a physician determines that the employee will be unable to function normally wearing a respirator or that the health of the employee will be impaired by use of a respirator.
- Contact lenses are not to be worn while using any type of respiratory protection.
- Excessive facial hair (beards) prohibits proper face fit and effectiveness of respirators; therefore, persons required to wear full-face or half-face respirators must not have beards, wide mustaches, goatees, extended sideburns, or Fu Manchu mustaches. All personnel wearing full-face or half-face respirators will be required to be clean shaven prior to each day's shift.

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PROJECT NAME: USAEC
LOCATION: Aberdeen Proving Ground, Maryland

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- Each respirator will be individually assigned and not interchanged among employees without cleaning and sanitizing.
- Regular eyeglasses cannot be worn with full-face respirators because they interfere with the face-piece seal. Inserts must be utilized.
- The respiratory protection used on site will be in compliance with OSHA, 29 CFR 1910.134.

15.3.1.3 Sampling Trains

During testing programs, flammable solvents may be used in the sampling trains. Material Safety Data Sheets (MSDS) will be provided by the test team for these substances.

15.3.1.4 Spiking Materials

During testing programs, the feed stream may be spiked with materials that are toxic, reactive, flammable, and/or corrosive. It will be incumbent upon the test team to properly store and handle the spiking materials, and to provide MSDSs for these materials.

15.3.2 Physical Hazards

Several physical hazards are expected to be encountered during field activities. These hazards are similar to those associated with any mechanical project. These hazards include those due to poor housekeeping, equipment operation, the use of hand and power tools, handling and storage of fuels, and use of electrical power.

15.3.2.1 Noise

Noise is a potential hazard associated with the operation of mechanical equipment including the fans, blowers, power tools, pumps, and generators.

All on-site personnel will wear hearing protection in areas where noise levels exceed a time-weighted average (TWA) of 85 decibels (dBA). Hearing protection will be worn during activities if levels are suspected or shown to exceed 85 dBA. The site H&S officer will continuously identify areas with high noise levels. High noise areas will initially be monitored with a sound level meter or dosimeter. Areas with consistently high noise levels will have

By: PO
Checked: PA
Approved: PA
Date: 01/12/95

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signs posted notifying personnel that hearing protection is required. All employees working on or near the CBC will receive annual hearing conservation refresher training.

15.3.2.2 Heat Stress

Heat stress is a significant potential hazard associated with the use of protective equipment in hot weather environments. The signs and symptoms of heat stress and the physiological monitoring requirements are discussed below.

Heat Stress Monitoring. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and individual characteristics. Extreme hot weather can cause physical discomfort, loss of efficiency, or personal injury.

Individuals vary in their susceptibility to heat stress. Factors that may predispose individuals to heat stress include:

- Lack of physical fitness
- Insufficient acclimation
- Age
- Dehydration
- Obesity
- Alcohol and/or drug use
- Medical conditions
- Infection
- Sunburn
- Diarrhea
- Chronic disease.

Reduced work tolerance and the increased risk of heat stress are directly influenced by the amount and type of personal protective equipment (PPE) worn. PPE adds weight and bulk, severely reduces the body's normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure.

Signs and Symptoms of Heat Stress. If normal body temperature fails to be maintained because of excessive heat, a number of physical reactions can occur ranging from mild to fatal. Heat-related problems include:

- **Heat Rash.** Caused by continuous exposure to heat and humidity and aggravated by chafing clothes. Heat rash decreases the body's ability to tolerate heat, as well as being a nuisance.
- **Heat Cramps.** Caused by profuse perspiration with inadequate fluid intake. Heat cramps cause painful muscle spasms and pain in the extremities and abdomen.
- **Heat Exhaustion.** Caused by increased stress on various organs to meet increased demand to cool the body. Heat exhaustion causes shallow breathing; pale, cool, moist skin; profuse sweating; and dizziness. Heat exhaustion can be alleviated by promptly moving the affected individual to a cool place to lie down and providing cool fluids to drink.
- **Heat Stroke.** The most severe form of heat stress. Heat stroke symptoms include hot, dry skin; no perspiration; nausea; dizziness; confusion; strong, rapid pulse; and coma. The body must be cooled immediately to prevent severe injury or death. Relief is possible only by emergency measures that quickly reduce body temperature to avoid irreparable damage to the body.

Heat Stress Prevention. One or more of the following practices will help reduce the probability of succumbing to heat stress:

- Provide plenty of liquids to replace the body fluids lost by perspiration. Fluid intake must be forced because, under conditions of heat stress, the normal thirst mechanism is not adequate to bring about a voluntary replacement of lost fluids.
- Provide cooling devices to aid natural body ventilation; however, these devices add weight and should be balanced against worker comfort.
- If possible, install mobile showers or hose-down facilities to reduce body temperature.
- If possible, provide cool protective clothing.
- If possible, conduct field operations in the early morning.

- Acclimate workers to heat conditions when field operations are conducted during hot weather.
- Train personnel to recognize the signs and symptoms of heat stress and its treatment.
- Rotate personnel to various job duties if possible.
- Provide shade or shelter to relieve personnel of exposure to the sun during rest periods.

Individuals succumbing to the symptoms of heat stress will notify the site H&S officer. Early detection and treatment of heat stress will prevent further serious illness or injury and lost work-time. Proper and effective heat stress treatment can prevent the onset of more serious heat stroke or exhaustion conditions. Individuals having progressed to heat exhaustion or heat stroke become more sensitive and predisposed to additional heat stress situations.

Physiological Monitoring. Ambient temperature and other environmental factors provide basic guidelines to implement work/rest periods. However, because individuals vary in their susceptibility to heat stress, physiological monitoring will be used to regulate each individual's response to heat stress when ambient temperatures exceed 70°F. Monitoring frequency will increase as ambient temperature increases. The three physiological parameters that each individual will monitor are:

- **Heart Rate.** Each individual will count his/her radial (wrist) pulse for 30 seconds as early as possible in the first rest period. If the heart rate of any individual on the sampling team exceeds 100 beats per minute at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same.
- **Oral Temperature.** Each individual will measure his/her oral temperature with a single-use clinical thermometer for 1 minute as early as possible in the first rest period. If the oral temperature exceeds 98.6°F at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same.
- **Body Water Loss.** Each individual will weigh his/her self before starting work and at the end of each work shift.

An individual is not permitted to return to work if his/her oral temperature exceeds 100.6°F.

Physiological monitoring information will be recorded on the Employee Record for Heat Stress. All monitoring will be performed by persons with a minimum of current Red Cross first-aid certification and individualized training to recognize the symptoms of heat stress. The site H&S officer will specify the work cycle period and the rest cycle period based on heat stress monitoring as per 1991-1992 ACGIH Threshold Limit Values (TLV).

15.3.2.3 Cold Stress

At certain times of the year, workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite and hypothermia, as well as slippery working surfaces, brittle equipment, and poor judgement.

To minimize the risk of the hazards of working in cold environments, workers will be trained to recognize the physiologic responses of the body to cold stress.

Physiologic Response to Cold Stress. Personnel who are exposed to temperatures below -10°F with wind speeds of greater than 5 miles per hour (mph) will be medically certified as suitable for such exposure. Employees will be protected from exposure to cold so that their body core temperature does not fall below 98.6°F. Lower body temperatures result in reduced alertness and a reduction in thought processes or loss of consciousness.

Pain in the extremities (i.e., fingers, toes, ears, and nose) may be the first signs of cold stress, because these areas have high surface area-to-volume ratios. Uncontrollable shivering occurs during exposure to cold when the body core temperature falls below 95°F. This symptom should be taken as a sign of danger, and work terminated with workers moving to a warm environment.

Ambient air temperature and the velocity of the wind influence the development of a cold injury. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. As a general rule, the greatest incremental increase in wind chill occurs when a 5-mph wind increases to 10 mph. Additionally, water conducts heat 240 times faster

than air. Thus, the body cools suddenly when chemical protective clothing is removed and clothing beneath is soaked with perspiration.

Signs and Symptoms of Cold Stress. Local injury resulting from cold is included in the generic term "frostbite;" however, there are several degrees of damage. Cold-related injuries include:

- Frost nip or incipient frostbite is characterized by sudden whitening or blanching of the skin.
- Superficial frostbite gives the skin a waxy appearance and is firm to the touch, but the tissue beneath is resilient. Superficial frostbite can be treated by covering the cheeks with warm hands, placing frostbitten fingers beneath the armpit next to the skin, or placing frostbitten feet beneath the clothing against the skin of a companion.
- Deep frostbite is characterized by cold, pale, and solid tissues. Deep frostbite is an extremely serious injury and affected individuals will seek medical attention.
- Systemic hypothermia is caused by exposure to freezing and rapidly dropping temperatures. Hypothermia symptoms are visually exhibited in five stages:
 - Shivering
 - Apathy, listlessness, sleepiness, and sometimes rapid cooling of the body to less than 95.5°F
 - Unconsciousness, glassy stare, slow pulse, and slow respiratory rate
 - Freezing of the extremities
 - Death.

Cold Stress Prevention. Prevention of frostbite is a function of whole-body protection:

- Adequate insulated clothing should be worn when the air temperature is below 40°F. Insulated coveralls, thermal socks, long underwear, hard hat liners, and other cold-weather gear aid in the prevention of hypothermia.
- Warm break areas and drinks (no caffeinated coffee) aid in warming the body.

- Train personnel to recognize the signs and symptoms of cold-related injuries and their treatment.
- Personnel will try to keep from getting their bodies and clothing wet, as this will only accelerate the effects of cold stress. However, if personnel should get wet, they will be allowed to dry off and change clothes.
- In addition, reduced work periods may be necessary in extreme conditions to allow rest in a warm area.

15.3.2.4 Burn Hazards

The surface of the CBC will be more than 300°F. Therefore, there is a real burn hazard. Other hot spots may be the ash, the baghouse, the fans, the stack, and all duct work. Burns can be prevented by avoiding contact with hot surfaces and by using the proper protective equipment when working on or near hot surfaces.

15.3.2.5 Explosion Hazard

The auxiliary fuel for the CBC will be natural gas. To prevent an explosive buildup of natural gas in the CBC the following will be observed:

- All auxiliary fuel valves will be installed in a double block and bleed manner
- CBC will be purged with air before the burner is started
- CBC temperature will be above 1300°F before auxiliary fuel is fed directly to the CBC
- Flame sensor will monitor the flame whenever a burner is in operation.

15.3.2.6 Fire Hazard

High temperature in the baghouse could cause the bags to catch fire. To prevent this problem, the temperature of the gases before the baghouse will be continuously monitored and if the temperature exceeds the manufacturer's recommended maximum temperature, the auxiliary fuel will be cut off.

15.3.2.7 Confined Space Entry

The CBC shall be evaluated to determine if any spaces are permit-required confined space. A permit-required confined space is a space that:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has a potential for engulfing an entrant
- Is configured such that an entrant could be trapped or asphyxiated
- Contains any other safety or health hazard.

A sign reading "DANGER--PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" will be posted at the entrance to any confined space.

Before entry into a permit-required confined space, a permit must be obtained from the site H&S officer. Only properly trained, authorized entrants may enter a confined space. A properly trained attendant must monitor the entrant from outside of the confined space. The appropriate PPE must be worn by the entrant and available for the rescue service.

15.3.3 Activity Hazard Analysis

This section provides an analysis of the likelihood of exposure to chemical and physical hazards and the risks associated with those exposures.

15.3.3.1 CBC Erection

The likelihood of exposure to chemical hazards is low, and the associated risk is low.

The likelihood of exposure to physical hazards is low to moderate. Heavy equipment operation and working at elevated locations pose moderate hazards during CBC erection. Other anticipated physical hazards include noise, electrical hazards, pinch points, heavy lifting, fuel handling, and heat stress. Control measures that will be employed to reduce the potential risk of exposure include properly maintained heavy equipment, employee training to recognize physical hazards, and adherence to the heat and cold stress guidelines contained in the HASP.

15.3.3.2 Performance Testing

During the performance test, samples of the red water will be analyzed. The red water may be spiked with organic chemicals and heavy metals, which present potential inhalation and skin contact hazards during the addition and subsequent sample handling activities. Control measures that can be employed to significantly reduce the potential risk of exposure include enclosed mixing and the use of PPE.

The likelihood of exposure to physical hazards is low to moderate. Equipment operation and material handling activities pose low hazards during trial burn preparation activities. Other physical hazards include heavy lifting, noise, electrical hazards, fire, and elevated work areas. Control measures that will be used to reduce the potential risk of exposure include proper equipment maintenance, trained operators, grounding and bonding during liquid transfer, adherence to lock-out/tag-out procedures, and utilization of proper tie-off procedures.

15.3.3.3 Maintenance Operations

The likelihood of exposure to chemical hazards during maintenance activities is low. The area of concern for this analysis is from the feed port to the stack. All red water that enters the CBC will be combusted, so red water (and its constituents) will not be present in the CBC during maintenance operations. A separate analysis of maintenance of the waste feed system should be considered, but this is beyond the scope of this document.

The likelihood of exposure to physical hazards is low to moderate. The risk associated with exposure to these agents is moderate, based upon the potential for serious injury from electrical hazards, pinch points, and moving equipment. Control measures that will be employed to reduce the potential risk of exposure include employee training and the preparation of site-specific standard operating procedures (SOP). Examples of these procedures include:

- Lockout/tagout procedure
- Confined space industrial
- Welding, cutting, and other hot work in hazardous locations
- Isolation of and entry into the CBC.

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LOCATION: Aberdeen Proving Ground, Maryland

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15.3.3.4 Operation of the CBC

A variety of chemical and physical hazards are associated with the operation of the CBC. The primary control measures include good engineering design, employee training, and the preparation of site-specific SOPs.

The likelihood of exposure to chemical hazards during routine operations is low and should be limited to exposure during sampling of the waste feed and the ash.

The likelihood of exposure to physical hazards is low to moderate. Hazards addressed in the SOPs will include noise, electrical hazards, work at elevations, slip/trip hazards, pinch points, and hot surfaces.

Either a task-specific hazard analysis or an SOP will be developed prior to starting a particular task.

By: PO
Checked: PA
Approved: PA
Date: 01/12/95

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APPENDIX E

**CONTROL OF HAZARDOUS ENERGY SOURCES
(LOCKOUT/TAGOUT)**

LOCKOUT PROCEDURE

I. PURPOSE

The purpose of this procedure is to establish and maintain a program of electrical and mechanical lockouts. It specifically covers the recommended lockout procedures for electrical, mechanical, and piping equipment. Its intent is to ensure the safety of all employees and others working on electrical and mechanical equipment for the purposes of installation, maintenance, cleanout, adjustment, repair, or modification.

II. ADMINISTRATION

The Project Manager is responsible for the establishment and implementation of proper lockout procedures at an IT Corporation facility or job site. The Project Manager and field supervisors are responsible for enforcing the various sections of the lockout procedures and for effectively training employees in the requirements of the procedures.

All employees are responsible for complying with the requirements of the established procedure.

Hardware - Special padlocks and DANGER tags used for lockout purposes shall be issued by the Project Manager. These padlocks and tags are the only type authorized for use in locking out energy sources and shall be used for no other purpose. Each padlock and key issued will have a unique identification number. A record of individuals who have been assigned lockout padlocks shall be maintained by the Project Manager.

Each padlock shall be keyed individually.

Annual Audits - The Supervisor, Project Manager and H&S Professional shall conduct audits to ensure that this lockout procedure is being properly implemented. The written results of these audits shall identify the machine or equipment inspected, the date inspected and the name of the person performing the audit.

III. REFERENCES

- A. OSHA Rule 29 CFR 1910.147, "Control of Hazardous Energy Sources (Lockout/Tagout)."
- B. "Safety Requirements for the Lockout/Tagout of Energy Sources," ANSI Z244.1-1982.

IV. PROCEDURE

A. General - The following procedures apply to both electrically energized equipment and mechanical lockouts.

1. A survey shall be made to identify all energy sources to be certain which switch, valve, or other energy-isolating devices apply to the equipment to be locked out. More than one energy source (electrical, mechanical, or other) may be involved. Questionable energy source problems shall be resolved before job authorization is obtained and lockout commences.
2. All energy-isolating devices, including electric disconnect switches and valves, shall be labeled to identify the equipment supplied and the type and magnitude of energy controlled.
3. All affected employees shall be notified that a lockout is required and why.
4. If the equipment is operating, normal procedures shall be used to shut it down (stop button pressed, toggle switch opened, gate valve closed, etc.).
5. Stored energy (such as that in capacitors; springs; elevated machine parts; rotating flywheels; hydraulic systems; and air, gas, steam, or water pressure) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.
6. All equipment must be deenergized and locked out at the source of energy (starter, field disconnect) for that particular piece of equipment before any work is performed on it. For electrically energized equipment, the "source" means the main electrical wires providing power to that piece of equipment. Lockouts must be performed on approved safety switch disconnects. (Push buttons and toggle switches are not considered approved.) Note: Before any equipment is deenergized, all push buttons or toggle switches must be OFF to eliminate any hazards.
7. DANGER tags shall be used to identify the person(s) locking out a piece of equipment. Every person working on a piece of equipment or assisting with such work must lock it out before performing that work. See Attachment 1 for Danger tags.
8. The key to any lock being used must be kept on the person performing the lockout.
9. No person should attempt to remove any lock from any locked-out equipment without the agreement of the persons who have locked out such equipment. In the event the persons who have locked out the equipment have left the facility or

job site, a supervisor may authorize removal of the lock(s) after ensuring that such removal will not endanger any employee or the equipment.

10. Each lockout performed on electrically energized equipment shall include the following steps (See Figure 1):
 - a. **Notify** - All affected employees shall be notified that a lockout is required and reason why.
 - b. **Lockout** - Switch shall be locked in the off position with an assigned individual lock.
 - c. **Tag** - Each lock shall be identified with a tag on which the performing individual lockout records his or her name and the date.
 - d. **Clear** - The person performing the lockout will visually observe that the equipment is clear of persons and things.
 - e. **Try** - The start switch shall be tried to ensure that the equipment has in fact been deenergized. If the system has multiple start switches, all start switches shall be tried.
 - f. **Stored energy** - Dissipate, bleed off or restrain energy stored in capacitors, springs, elevated machine members, rotating flywheel, hydraulic systems.
 - g. **Keys** - The key(s) to the lock(s) shall be kept by the person performing the lockout at all times when working on equipment.
11. Some equipment, because of its nature or function, cannot be locked out in the preceding manner. Such equipment shall be de-energized in accordance with References A and B and agreed upon by all parties involved.
12. Before energy is restored to the equipment/process, an authorized individual shall
 - a. Visually inspect the work area to ensure that tools and equipment have been removed and the unit is ready to operate.
 - b. Conduct a head count or otherwise ensure that all personnel are in the clear.
 - c. See that each individual lock be removed from each energy isolating device by the person who applied the lock. Exceptions are allowed only as described in Paragraph 9.

B. Mechanical Lockouts

1. All nonelectrical equipment that requires lockout will be locked out in a manner appropriate for that piece of equipment. For example, gate valves shall be chained and locked in a manner that will prevent them from being opened or closed, depending on the requirements. (See Figure 2).
2. When entry into tanks or vessels is required, lines into that vessel shall be secured as follows:
 - a. All lines to the vessel shall be disconnected, blanked, or blind-flanged.
 - b. A list of blanks, disconnections, and/or blind flanges shall be maintained as part of the vessel entry permit.

Note: A confined-space entry permit must be obtained, and all requirements of the confined-space entry procedure shall be met.

3. Where double block-and-bleed systems have been installed (see Figure 3), these valves shall be used and posted with DANGER tags, as stated in Section IV.A.7. Where some question exists regarding the integrity of tagged valves, locks shall be employed to ensure the inoperability of these valves.
4. If necessary, mechanical devices such as agitators, tynes, and pumps shall be mechanically disconnected from the system to ensure the safety of individuals working on the equipment.

C. Procedure Involving More Than One Person

1. In the preceding sections, if more than one individual is required to lock out equipment, each shall place his or her own personal lock on the energy-isolating device(s).
2. One designated person of a work crew, or a supervisor with the knowledge of the crew, may lock out equipment for the whole crew. It is the responsibility of the designated person to carry out all steps of the lockout procedure and to inform the crew when it is safe to work on the equipment. In addition, this designated person shall not remove a crew lock until it has been verified that all individuals and tools are in the clear. Refer to Section IV.A.12.
3. If equipment will be locked out for more than one shift, the individual or work crew leader from the preceding shift shall notify the individual or work crew leader on the following shift, of the work status and lockout requirements of the job before removing the preceding shift's padlock. The following shift's personnel shall be responsible for applying necessary lockouts for the shift.

D. Outside Contractors

Whenever outside personnel may be affected by, or perform activities covered by this procedure, these personnel shall be notified of this Lockout Procedure. In addition, Lockout procedures used by other contractors shall be compatible with the IT Lockout Procedure. The Project Manager is responsible for notifying outside contractors of these requirements.

E. Other - Any situation not specified in the preceding that requires a lockout will be specifically established via the Site Specific Health and Safety Plan.

The opening of motor control center (MCC) panels, disconnect switches, line starters, or any other electrical enclosures by anyone other than qualified personnel is prohibited. The Project Manager will determine those individuals qualified to open electrical enclosures.

F. Training - All employees, supervisors, and management whose job activities may include or be affected by the use of a lockout to control hazardous energy sources shall receive initial training on proper implementation of this procedure. Followup training in all aspects of the lockout procedure will be administered by foremen on an annual basis. Written training records, which includes employee's name and training date, shall be maintained by the Health, Safety and Training Department

V. REVIEW AND REVISION

This procedure will be reviewed triannually and revised as needed.

DANGER

**EQUIPMENT
LOCKED OUT
BY**

SIGNED BY _____

DATE _____

DANGER

DO NOT REMOVE THIS TAG

**THIS TAG & LOCK
TO BE REMOVED
ONLY BY PERSON
SHOWN ON BACK**

SEE OTHER SIDE

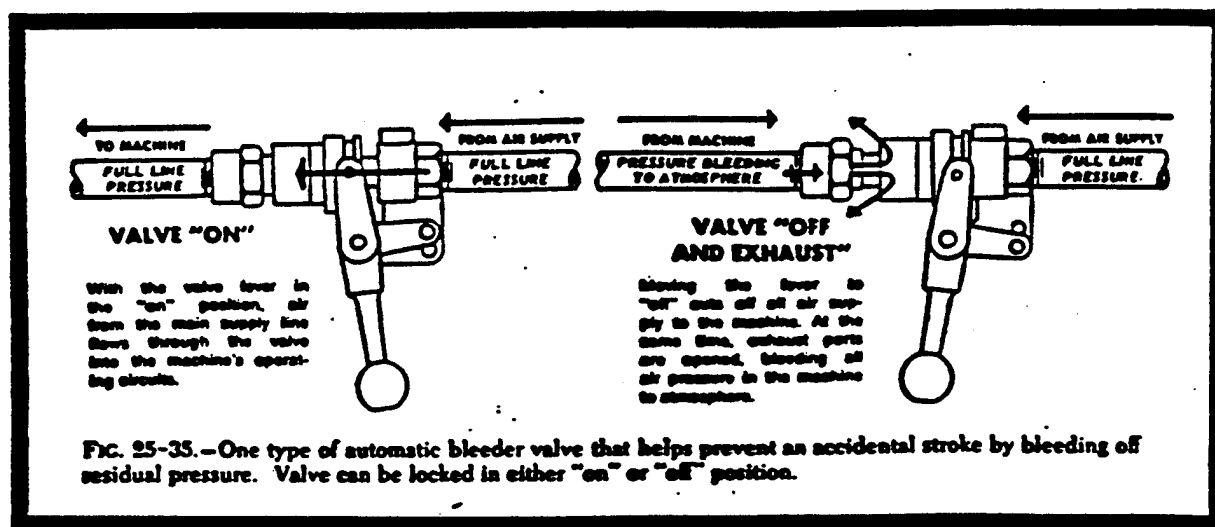
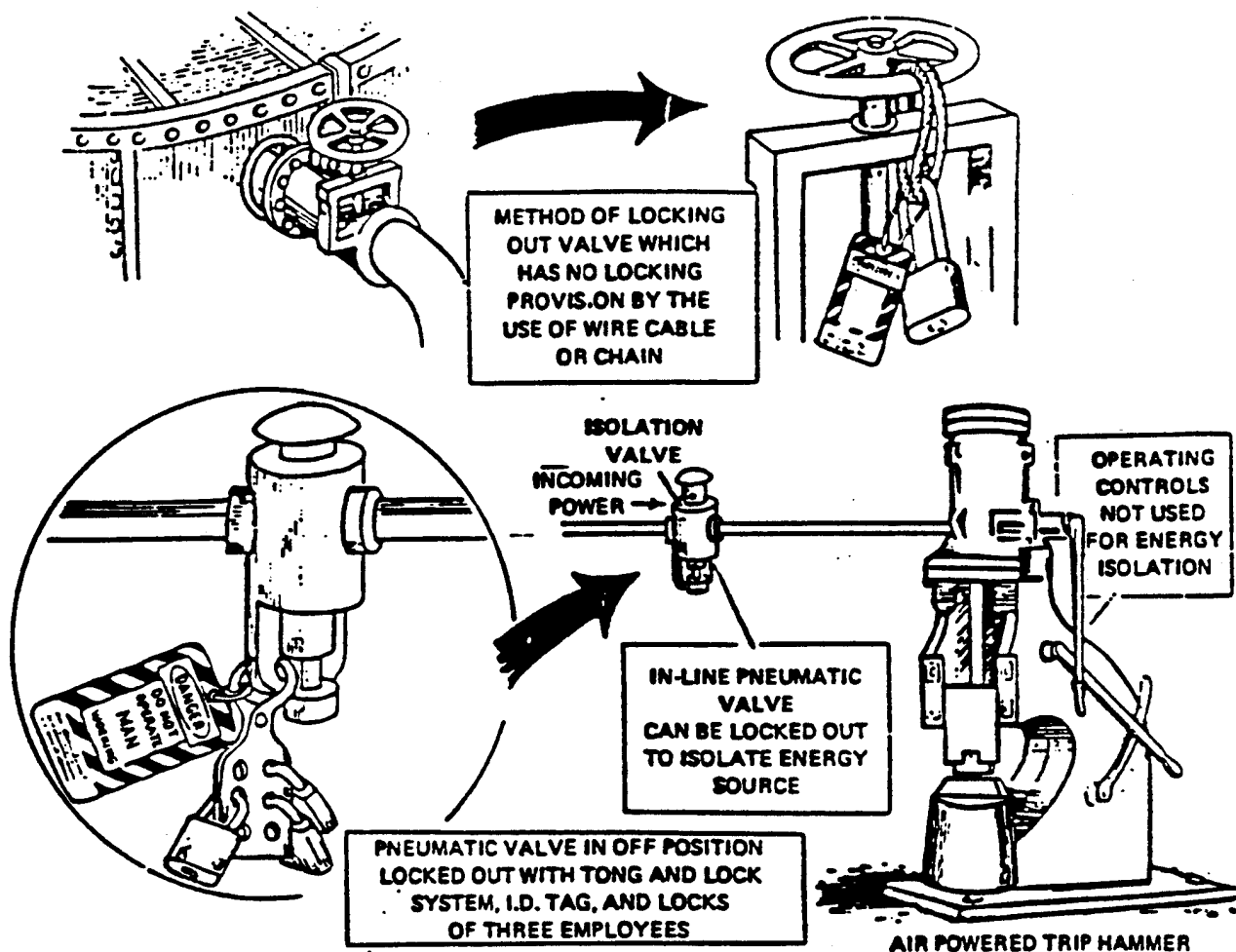


Figure 2. Lockout/tagout procedure for hydraulic-pneumatic energy source.

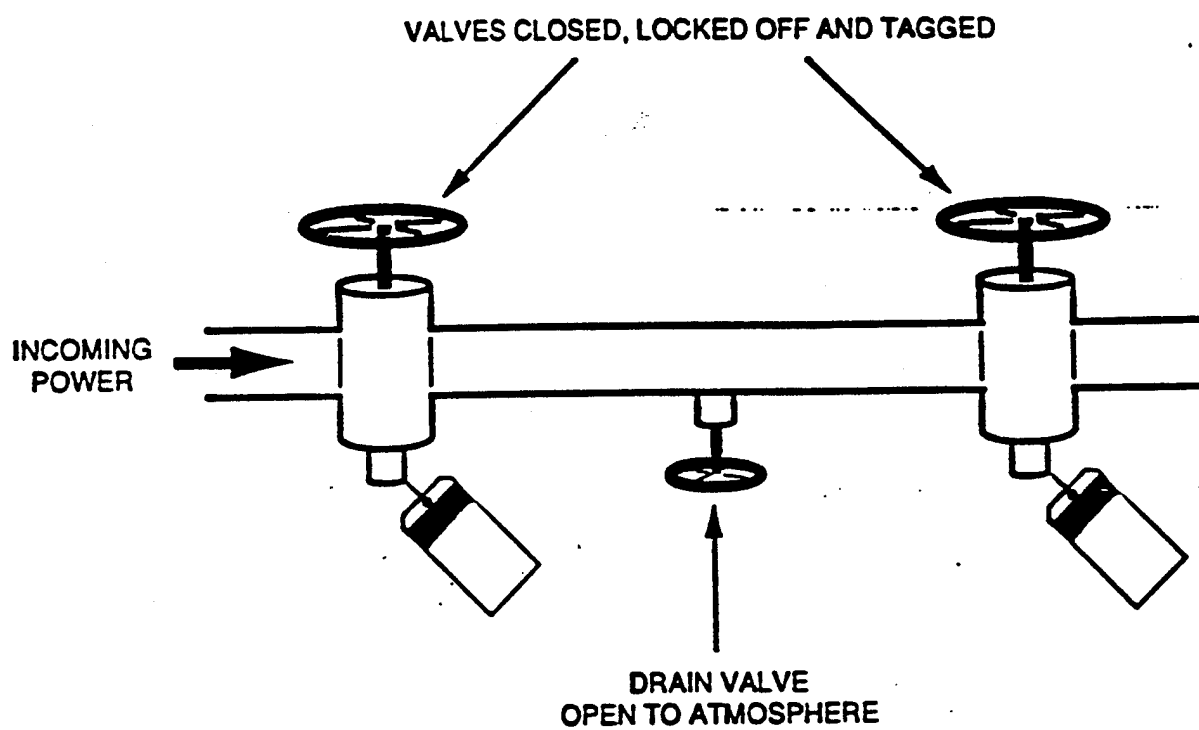
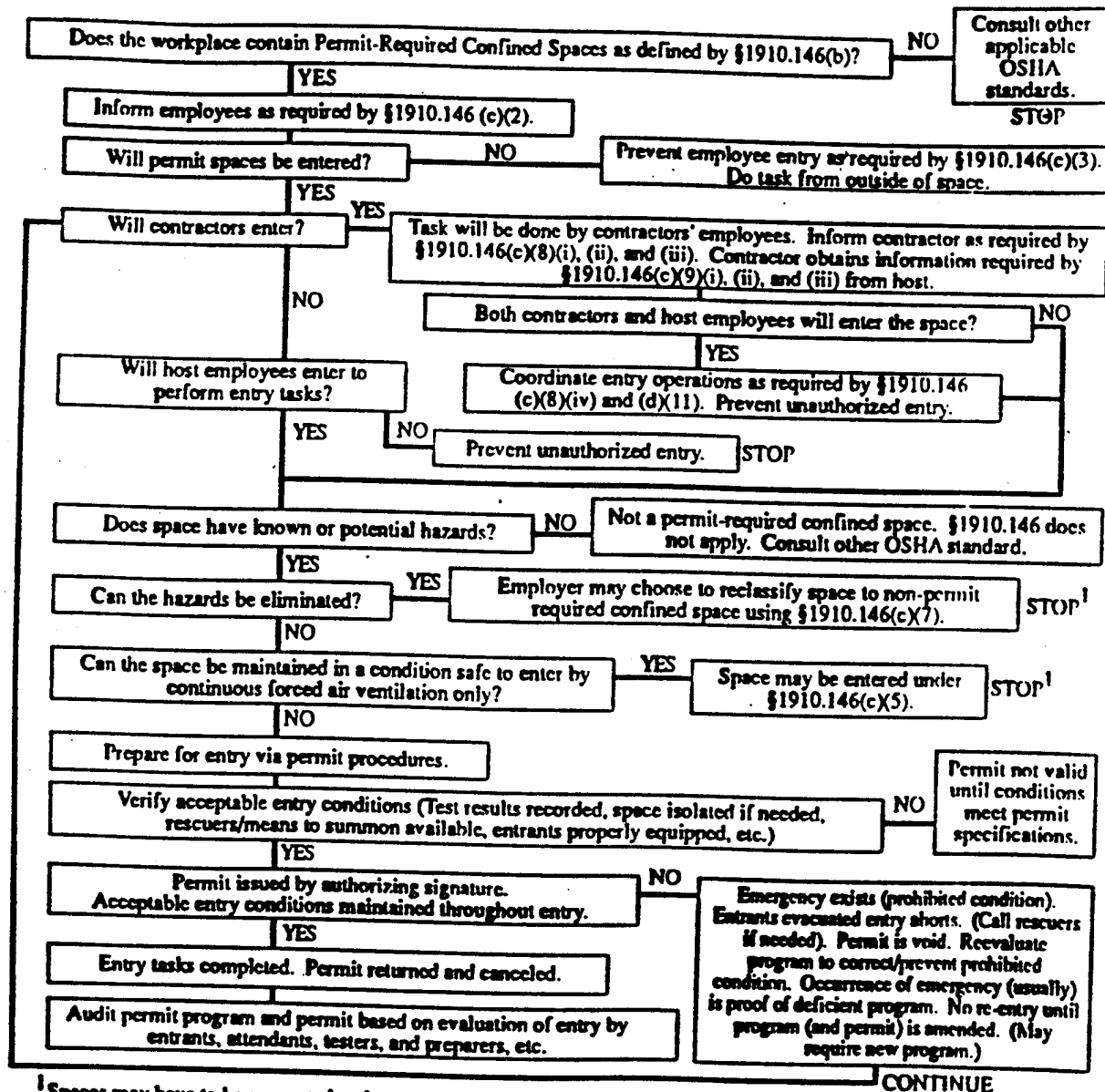


Figure 3. Double block and bleed system.

APPENDIX F

**PERMIT-REQUIRED CONFINED SPACE
DECISION FLOWCHART**

PERMIT-REQUIRED CONFINED SPACE DECISION FLOWCHART



¹ Spaces may have to be evacuated and re-evaluated if hazards arise during entry

APPENDIX G
CHEMICAL INFORMATION

**Section 1. Material Identification**

Acetic Acid (CH_3COOH): Description: Derived by fermentative oxidation of ethanol, liquid and vapor phase oxidation of petroleum gases with a catalyst, hydration of acetic anhydride, or by reacting methyl alcohol with carbon monoxide in presence of a catalyst. Occurs naturally in wines, aged cheese, orange juice, and vinegar (3 to 6%). Glacial acetic acid is the concentrated form and is diluted with water to form varying concentrations. Used in production of inorganic and organic acetates and organic esters, in dyeing, pharmaceuticals, canning, food processing, pigment production, and in textile printing; as a food additive, latex coagulant, oil well acidizer, and a solvent for gums, resins, and volatile oils.

Other Designations: CAS No. 64-19-7, Aci-Jel, ethanoic acid, ethylic acid, glacial acetic acid, methane carboxylic acid, pyroigneous acid, vinegar acid.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: Acetic acid is highly corrosive and can seriously damage living tissue. Prolonged inhalation of even low acetic acid percentages such as found in vinegar (3 to 6 %) can cause severe irritation of mucous membranes. Concentrated acetic acid is highly flammable while concentrations below 50% are nonflammable. Reaction with water releases heat and irritating vapors.

R 2
I 2-3*
S 2-3*
K 1-2*
* Applies to
glacial acetic
acid

Section 2. Ingredients and Occupational Exposure Limits

Acetic acid. Glacial acetic acid is 99.8%. Impurities include trace amounts of chloride, lead, iron, sulfate, and sulfur dioxide.

1991 OSHA PEL
8-hr TWA: 10 ppm (25 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 10 ppm (25 mg/m³)
STEL: 15 ppm (37 mg/m³)

1992-93 ACGIH TLVs

TWA: 10 ppm (25 mg/m³)

STEL: 15 ppm (37 mg/m³)

1990 DFG (Germany) MAK

TWA: 10 ppm (25 mg/m³)

Category I: Local irritants

Peak Exposure Limit: 20 ppm, 5 min momentary value, 8/shift

1985-86 Toxicity Data*

Human, skin: 50 mg/24 hr caused mild irritation.

Man, unreported route, LD₅₀: 308 mg/kg; toxic effects not yet reviewed

Human, oral, TD₅₀: 1470 µg/kg caused functional changes in the esophagus and bleeding in the small & large intestine.

Human, inhalation, TC₅₀: 816 ppm/3 min caused olfactory and eye effects with respiratory changes.

Rat, oral, LD₅₀: 3530 mg/kg; no toxic effect noted

Rabbit, eye (open patch test): 50 µg caused severe irritation.

* See NIOSH, RTECS (AF1225000, % not specified; synonyms include *vinegar* and *glacial acetic acid*), (AF1300000, 25 to 80%), (AF1340000, 80 to 100%) for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 244 °F, 118 °C (760 mm Hg); 176 °F, 80 °C (202 mm Hg)

Melting Point: 62 °F (16.6 °C), *congeals at* 6.8 °F (-14 °C)

Water Solubility: Soluble, *releases heat & toxic vapors*

Other Solubilities: Soluble in ethanol, ether, glycerol, glycerine, acetone, benzene, and carbon tetrachloride. Insoluble in carbon disulfide.

Vapor Pressure: 11 mm Hg at 68 °F (20 °C)

Density of Saturated Air (Air = 1): 1.02

Molecular Weight: 60.05

Density: 1.0492 at 68 °F (20/4 °C)

pH: 1 M (2.4), 0.1 M (2.9), 0.01 M (3.4)

Viscosity: 1.22 cP at 68 °F (20 °C)

Refraction Index: 1.3715 at 68 °F (20 °C)

Wt/Gal: 8.64 lb/gal at 68 °F (20 °C)

Evaporation Rate: 0.24 g/m²/s at 25 °C and wind at 4.5 m/s

Appearance and Odor: Colorless, hygroscopic liquid or crystals with a pungent (vinegar) odor. The odor threshold = 0.037 to 0.15 ppm.

Section 4. Fire and Explosion Data

Flash Point: 103 °F (39 °C) OC **Autoignition Temperature:** 800 to 916 °F (426 to 516 °C) **LEL:** 5.4 % v/v **UEL:** 16% v/v at 212 °F (100 °C)

Extinguishing Media: Concentrations below 50% are nonflammable. Greater than 50% poses a fire hazard directly and by releasing flammable hydrogen gas from contact with many metals. Fight fire with dry chemical, carbon dioxide, water spray, or 'alcohol-resistant' foam.

Unusual Fire or Explosion Hazards: Burning Rate = 1.6 mm/min. Container may explode in heat of fire. Concentrated acetic acid poses an explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. If possible without risk, remove container from fire area. If impossible apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Acetic acid contracts slightly upon freezing and releases heat and toxic, irritating vapors when mixed with water. It is stable at room temperature in closed containers as long as temperatures are kept above freezing; even a slight contraction can cause the container to burst. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Attacks some forms of plastics, rubber, and coatings. Other incompatibles include: acetaldehyde, 5-azidotetrazole, 2-aminoethanol, ammonium nitrate, bromine trifluoride, chromic acid, chlorine trifluoride, chlorosulfonic acid, diallyl-methyl carbinol + ozone, ethylenediamine, hydrogen peroxide, sodium peroxide, potassium hydroxide, sodium hydroxide, potassium permanganate, nitric acid + acetone, oleum, perchloric acid, phosphorus trichloride, potassium *t*-butoxide, phosphorus isocyanate, and *n*-xylene. It can attack a wide variety of metals to release hydrogen gas. **Conditions to Avoid:** Contact with heat, ignition sources, carbonates, hydroxides, oxides, phosphates, and other incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of acetic acid can produce carbon dioxide (CO₂), carbon monoxide (CO), and toxic, irritating vapors.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,⁽¹⁶⁴⁾ NTP,⁽¹⁶⁹⁾ and OSHA⁽¹⁶⁴⁾ do not list acetic acid as a carcinogen. **Summary of Risks:** Splashes of low acetic acid concentrations as found in vinegar (4 to 10%) are painful to the eye and vapors are irritating to the respiratory tract. The skin is only mildly affected by low concentrations; above 50% irritation becomes severe and leads to corrosion and blistering. Vapor from concentrated acid (glacial) is extremely irritating and can cause bronchial constriction. Delayed breathing difficulties may occur. Chronic exposure causes continued inflammation of the respiratory tract, erosion of tooth enamel and darkening and thickening of the skin (usually hands). **Target Organs:** Eyes, teeth, skin, respiratory system, (blood & kidney injury evident from ingestion only). **Primary Entry Routes:** Inhalation, skin and eye contact, ingestion. **Medical Conditions Aggravated by Long-Term Exposure:** Skin and respiratory disorders. **Acute Effects:** Exposure to ~ 10 ppm for 8 hr has caused eye, nose, and throat irritation; 50 ppm caused intensive eye watering and 100 ppm caused serious lung irritation and is intolerable to most individuals. Splashes to the eyes are very painful, resulting in blood build up in the conjunctiva and possible injury to epithelium or permanent opacification of the cornea. Acute skin contact with dilute solutions is only mildly irritating; concentrated solutions are highly corrosive causing redness, blistering and severe burns. Ingestion is unlikely in an industrial setting but if it occurs, as little as 1 mL of the concentrated acid (glacial) can cause perforation of the esophagus. Other ingestion symptoms include upper digestive tract ulcerations, bloody vomitus, diarrhea, shock, free hemoglobin in the blood (due to red blood cell destruction), defective urination, uremia (accumulation in the blood of constituents usually excreted in the urine), circulatory distress, and death due to coma. **Chronic Effects:** Vapor inhalation of 200 ppm for an unspecified number of years caused edema (fluid buildup) around the eyelids, lymph node enlargement, blood buildup in the conjunctiva, inflammation of the pharynx, respiratory passages, and mucous membranes, and tooth enamel erosion. Workers have complained of digestive disorders including heartburn and constipation. Repeated skin contact causes dryness and cracking and eventually, thickening and darkening of the skin. Cuts and abrasions heal slowly. **FIRST AID** **Eyes:** Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. Do not induce vomiting! **Note to Physicians:** Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel must protect against inhalation and skin/eye contact. Shut off all ignition sources. Use water spray to reduce vapor and dilute spills to nonflammable mixtures (< 50% acetic acid); do not get water inside container. Contain any wastewater. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Neutralize any residue by wiping up with sodium bicarbonate or soda ash solutions. For large spills, dike far ahead for reclamation or disposal. Report any release in excess of 5000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Mosquito fish, TLm = 251 ppm/24 hr; fathead minnow, LC₅₀ = 315 mg/L/1 hr, 122 mg/L/24 hr & 88 mg/L/96 hr; bluegill, TLm = 75 mg/L/96 hr. **Environmental Degradation:** If released on land, acetic acid will spread on the surface and penetrate the soil at a rate dependent on soil type and water content. In water, it is readily degradable and dilute solutions will neutralize to acetate salts. Acetic acid shows no potential for bioaccumulation. **Disposal:** Neutralize with crushed limestone, soda ash, or lime; mix with a flammable solvent, and burn in an incinerator with an afterburner. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant
(29 CFR 1910.1000, Table Z-1-A)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per CWA, Sec. 311 (b)(4)]

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For <250 ppm, use any supplied-air respirator (SAR) operated in continuous-flow mode or any powered, air-purifying respirator with appropriate organic vapor cartridges. For <500 ppm, use any chemical cartridge respirator with a full facepiece and organic vapor cartridges, any SCBA or SAR with a full facepiece. For <1000 ppm, use any SAR with a full facepiece operated in pressure-demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.** If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Butyl rubber and Teflon with breakthrough times (BT) >8 hr, polyethylene and Neoprene with BT >4 hr, and Viton are suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove acetic acid from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in glass or stainless steel containers, polyethylene carboys, or polyethylene-lined drums. Keep in a dry area above freezing pt. (62 °F/16.6 °C) and away from ignition sources or oxidizers. Outside or detached storage is preferred. Periodically inspect containers. Install Class I, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the skin, eyes, teeth, and respiratory tract.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Acetic acid solution, > 10% but < than 80%, by mass; Acetic acid, glacial or Acetic acid solution, > 80% acid by mass.

DOT Hazard Class: 8

ID No.: UN2790, UN2789

DOT Packing Group: II

DOT Label: Corrosive

Special Provisions: A3, A6, A7, A10, B2, T8

Packaging Authorizations

a) Exceptions: 173.154

b) Non-bulk Packaging: 173.202

c) Bulk Packaging: 173.242

Quantity Limitations

a) Passenger Aircraft or Railcar: 1L

b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements

a) Vessel Stowage: A

b) Other: 112; 12, 21, 48

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 176

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MPH, MD

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*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 82
COMMON CHEMICAL NAME : Aluminum
SYNONYMS :
* Aluminum flake
* Aluminum powder
* Metana
* Norsk aluminum
* Aluminum 27
CAS REGISTRY NUMBER : 7429-90-5
PIN (UN/NA NUMBER(S)) : 1309 1396
CHEMICAL FAMILY : Elemental aluminum
MOLECULAR FORMULA : Al

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :
Light, silvery-white, soft, metallic solid; odourless.
ODOUR THRESHOLD :
Odourless
WARNING PROPERTIES :
None - odourless and essentially non-irritating
COMPOSITION/PURITY :
Commercially pure aluminum may contain up to 1% iron, silica and copper.
USES AND OCCURRENCES :
Used in the manufacture of construction materials, containers, electrical equipment, appliances, powders for alloys and paints, explosives, photoengraving plates, permanent magnets, printing inks; automobile industry, aircraft industry; production of inorganic and organic aluminum chemicals; therapeutic and pharmaceutical agent; hydrate for water purification; reducing agent.

*** SECTION 3. HAZARDS IDENTIFICATION ***

** POTENTIAL HEALTH EFFECTS **

EFFECTS OF SHORT-TERM (ACUTE) EXPOSURE :
INHALATION :
No detectable short-term responses. High concentrations of dust may be physically irritating and cause deposits of dust in nasal passages.
SKIN CONTACT :
Aluminum dust generally is not irritating to the skin. May cause irritation by abrasion.
EYE CONTACT :
Dust may deposit in the eyes. Generally not irritating. Larger aluminum particles may cause irritation due to abrasion.
INGESTION :
Amount of aluminum swallowed during exposure in the workplace should not cause toxic effects. Swallowing large quantities of aluminum dust may cause abrasive irritation of the stomach and intestine.
EFFECTS OF LONG-TERM (CHRONIC) EXPOSURE :

Prolonged or repeated exposure to fine aluminum powder may cause scarring of lung tissue (pulmonary fibrosis). The degree of lung injury is related to aluminum particle size, concentration in the air, duration of exposure and presence of other contaminants in the workplace. Signs and symptoms of lung injury include difficulty breathing, coughing, drowsiness, loss of appetite and rapid breathing.

Asthma-like symptoms have been reported in association with refining aluminum material and fumes from aluminum soldering (1).

One case of brain damage (encephalopathy) has occurred in connection with scarring of the lung tissue due to exposure to aluminum dust. Aluminum content of the brain was 20 times normal levels. There may be a relationship between aluminum and a brain disease which causes early senility (Alzheimer's disease), but at present this is controversial and unproven (3,4).

CARCINOGENICITY :

No cases of cancer caused solely by exposure to aluminum have been reported (2).

TERATOGENICITY AND EMBRYOTOXICITY :

Insufficient information

REPRODUCTIVE TOXICITY :

Insufficient information

MUTAGENICITY :

Insufficient information

TOXICOLOGICALLY SYNERGISTIC MATERIALS :

Insufficient information

POTENTIAL FOR ACCUMULATION :

Ingested aluminum is readily excreted (eliminated) in feces. Small amounts may be absorbed but nearly all is excreted in urine. Inhaled aluminum particles may remain deposited in the lungs.

***** SECTION 4. FIRST AID MEASURES *****

INHALATION :

If symptoms are experienced, remove source of contamination or move victim to fresh air. Obtain medical advice immediately.

SKIN CONTACT :

If irritation occurs, gently blot or brush away excess chemical quickly.

EYE CONTACT :

If irritation occurs, flush the contaminated eye(s) with lukewarm, gently flowing water for 10 minutes, by the clock, holding the eyelid(s) open. Obtain medical advice immediately.

INGESTION :

Never give anything by mouth if victim is rapidly losing consciousness or is unconscious or convulsing. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz) of water to dilute material in stomach. Obtain medical advice immediately.

FIRST AID COMMENTS :

Consult a physician and/or the nearest Poison Control Centre for severe exposures.

***** SECTION 5. FIRE FIGHTING MEASURES *****

FLASH POINT :

Not applicable to solids

LOWER FLAMMABLE (EXPLOSIVE) LIMIT (LFL/LEL) :

Airborne dust can be ignited and may explode (5).

UPPER FLAMMABLE (EXPLOSIVE) LIMIT (UFL/UEL) :

Not applicable

AUTOIGNITION (IGNITION) TEMPERATURE :

590 deg C (1,094 deg F)

EXPLOSION DATA - SENSITIVITY TO MECHANICAL IMPACT :

Not sensitive

EXPLOSION DATA - SENSITIVITY TO STATIC CHARGE :

Not available

FIRE HAZARD COMMENTS :

Under certain conditions, a dust cloud of this material can explode when ignited by a spark or flame. Explosions of aluminum dusts have occurred in industry (5). When evaluating the explosion hazard of a specific process or sample of material, the important factors to consider include: particle size and shape, the nature of any impurities, humidity, dust concentration, and extent of containment.

EXTINGUISHING MEDIA :

Isolate large fires and allow to burn out. Use sand, talc or sodium chloride to control small fires.

FIRE FIGHTING INSTRUCTIONS :

Do not use water. Dust can form explosive mixtures in air. Bulk dust when damp may heat spontaneously. Hazard greater as particle size of aluminum decreases.

** NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD INDEX **

NFPA - HEALTH

: 0 - Exposure, under fire conditions, would be no more hazardous than ordinary combustible material (aluminum, metallic powder).

NFPA - FLAMMABILITY

: 1 - Must be preheated before ignition can occur (aluminum, metallic powder).

NFPA - REACTIVITY

: 1 - Normally stable but can become unstable at elevated temperatures and pressures, or may react non-violently with water (aluminum, metallic powder).

*** SECTION 6. ACCIDENTAL RELEASE MEASURES ***

PRECAUTIONS :

Eliminate all ignition sources. Wear appropriate personal protective equipment.

CLEAN-UP :

Do not touch spilled material. Stop or reduce leak if safe to do so. Shovel into clean, dry, labelled containers and cover. Flush area with water. Keep combustibles (wood, paper, oil, clothing, etc.) away from spilled material.

*** SECTION 7. HANDLING AND STORAGE ***

HANDLING :

Avoid generating dust. Use dust-tight containers. Prevent accumulations of dust. Keep material away from sparks, flames and other ignition sources. Post 'No Smoking' signs in area of use.

STORAGE :

Store in a cool, dry, well-ventilated area, out of direct sunlight, away from acids, caustics, oxidizing materials and chlorinated hydrocarbons. Keep away from heat and ignition sources. Store in labelled, dust-tight containers, kept closed when not in use and empty. Protect from damage. Keep powdered aluminum product dry. Avoid any dust build-up by frequent cleaning and suitable construction of storage area.

*** SECTION 6. EXPOSURE CONTROLS/PERSONAL PROTECTION ***

NOTE : Exposure to this material can be controlled in many ways. The measures appropriate for a particular worksite depend on how this material is used and on the extent of exposure. This general information can be used to help develop specific control measures. Ensure that control systems are properly designed and maintained. Comply with occupational, environmental, fire, and other applicable regulations.

SAMPLING AND ANALYSIS :

Use appropriate instrumentation and sampling strategy (location, timing, duration, frequency, and number of samples). Interpretation of the sampling results is related to these variables and the analytical method. NIOSH METHOD(S): 2013 - NIOSH Manual of Analytical Methods. 3rd edition. Vol. 1: 7300 - NIOSH Manual of Analytical Methods. 3rd edition. Vol. 1.

ENGINEERING CONTROLS :

Engineering control methods to reduce hazardous exposures are preferred. Methods include mechanical ventilation (dilution and local exhaust), process or personnel enclosure, control of process conditions, and process modification (e.g., substitution of a less hazardous material). Administrative controls and personal protective equipment may also be required. Use a non-sparking, grounded ventilation system separate from other exhaust ventilation systems. Exhaust directly to the outside. Locate dust collectors outside or in an isolated area. Provide dust collectors with explosion vents. Supply sufficient replacement air to make up for air removed by exhaust system.

PERSONAL PROTECTIVE EQUIPMENT :

If engineering controls and work practices are not effective in controlling exposure to aluminum dust, then wear suitable personal protective equipment including approved respiratory protection. Have appropriate personal protective equipment available for use in emergencies such as spills or fire. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance, inspection, cleaning and evaluation. Refer to the CSA Standard Z94.4-93, "Selection, Care, and Use of Respirators" available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

RESPIRATORY PROTECTION GUIDELINES :

No specific guidelines are available. Consult chemical manufacturer/supplier for advice.

EYE/FACE PROTECTION :

It is good practice to wear chemical safety goggles.

SKIN PROTECTION :

Gloves or coveralls may be worn to prevent excessive dust deposits and abrasion.

RESISTANCE OF MATERIALS FOR PROTECTIVE CLOTHING :

Most common materials should provide adequate protection. NOTE: Resistance of specific materials can vary from product to product. Evaluate resistance under conditions of use and maintain clothing carefully.

EXPOSURE CONTROLS/PERSONAL PROTECTION COMMENTS :

Do not eat, drink, or smoke in work areas. Wash hands thoroughly after handling this material. Maintain good housekeeping.

*** EXPOSURE GUIDELINES ***

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF

TIME-WEIGHTED AVERAGE (TLV-TWA) : 10 mg/m³

TLV COMMENTS :

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 15 mg/m³ (total dust, as Al); 5 mg/m³
(respirable fraction, as Al)

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 15 mg/m³ (total dust - Al); 5 mg/m³
(respirable fraction - Al)

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 26.98

CONVERSION FACTOR :

Not applicable

MELTING POINT : 660.37 deg C (1,221 deg F)

BOILING POINT : 2,467 deg C (4,473 deg F)

RELATIVE DENSITY (SPECIFIC GRAVITY) :

2.702 at 20 deg C (water=1)

SOLUBILITY IN WATER :

Insoluble

SOLUBILITY IN OTHER LIQUIDS :

Insoluble in most organic solvents. Forms soluble salts with alkalis, sulfuric acid and hydrochloric acid. Insoluble in hot acetic acid and concentrated nitric acid.

VAPOUR DENSITY : Not applicable

VAPOUR PRESSURE : Negligible at 25 deg C; 1 mm Hg at 1,284 deg C

SATURATION VAPOUR CONCENTRATION : Not applicable

EVAPORATION RATE : Not applicable

pH VALUE : Not applicable

CRITICAL TEMPERATURE : Not available

COEFFICIENT OF OIL/WATER DISTRIBUTION (PARTITION COEFFICIENT) :

Not applicable

*** SECTION 10. STABILITY AND REACTIVITY ***

STABILITY :

Bulk solid is stable. Dust forms explosive mixtures in air. Bulk dust when damp may heat spontaneously. Hazard is greater as size of particles

decreases.

HAZARDOUS POLYMERIZATION :

Does not occur

HAZARDOUS DECOMPOSITION PRODUCTS :

None

INCOMPATIBILITY - MATERIALS TO AVOID :

STRONG BASES (e.g. sodium hydroxide) - releases flammable hydrogen gas

STRONG ACIDS (e.g. sulfuric acid, hydrochloric acid) - forms soluble salts, releases hydrogen gas

METALS (e.g. iron, zinc) - may corrode rapidly when wet

METAL OXIDES (e.g. ferric oxide) - "Thermite" - mixtures with powdered aluminum react vigorously when ignited. Temperature may reach 2,200 deg C.

HALOGENS (e.g. bromine, chlorine, iodine, iodine monochloride) - mixtures may ignite

OXIDIZING AGENTS (e.g. oxygen, sodium peroxide, chromic acid) - may react violently or ignite

ALCOHOLS (e.g. propanol, butanol) - react when heated to form alkoxides

HALOGENATED HYDROCARBONS (e.g. carbon tetrachloride, trichlorotrifluoromethane, dichlorodifluoromethane) - heating or friction may cause explosive reaction

WATER - bulk aluminum powder may heat spontaneously when wet; flammable hydrogen gas may form. Mixtures of aluminum powder and water can explode if detonated.

CORROSIVITY TO METALS :

Not corrosive

***** SECTION 11. TOXICOLOGICAL INFORMATION *****

INHALATION: Rats, guinea-pigs and hamsters exposed to very fine metallic aluminum powder did not develop scarring of the lung tissues. Clearance of dust deposits from the lungs was rapid after exposure was discontinued. Scarring of lung tissue resulted after rats received injections of 100 mg aluminum powder directly into the air passage leading to the lungs (trachea).

INGESTION: High levels of aluminum in the diet may inhibit absorption of phosphorus into the body. Animals given about 1,400 ppm aluminum in the diet had decreased phosphorus in the blood and bone.

EYES: Aluminum particles implanted in rabbit eyes caused slight inflammation of the coating of the eye (1).

CARCINOGENICITY: Aluminum metal powder does not cause cancer by various routes in animal studies (3).

MUTAGENICITY: Animal studies show that aluminum is not mutagenic.

***** SECTION 12. ECOLOGICAL INFORMATION *****

NOTE : This section is under development.

***** SECTION 13. DISPOSAL CONSIDERATIONS *****

Review federal, provincial and local government requirements prior to disposal. Store material for disposal as indicated in section on Storage Conditions. Disposal by landfill may be acceptable or aluminum may be recovered for recycling.

***** SECTION 14. TRANSPORT INFORMATION *****

**** TRANSPORTATION OF DANGEROUS GOODS (TDG) SHIPPING INFORMATION ****

SHIPPING NAME AND DESCRIPTION: Aluminum powder

PRODUCT IDENTIFICATION NUMBER (PIN): 1309

CLASSIFICATION: 4.1 - Flammable solid

SPECIAL PROVISIONS: ----

PACKING GROUP: II or III

REGULATED LIMIT: ----

SHIPPING NAME AND DESCRIPTION: Aluminum powder, uncoated, non-pyrophoric

PRODUCT IDENTIFICATION NUMBER (PIN): 1396

CLASSIFICATION: 4.3 - Substance that, on contact with water or water vapour, emits dangerous quantities of flammable gases or becomes spontaneously combustible

SPECIAL PROVISIONS: ----

PACKING GROUP: II or III

REGULATED LIMIT: ----

NOTE: This information incorporates Schedule No. 18 amendments to the Transportation of Dangerous Goods Act, 1992, effective October 1, 1994.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

PROPOSED WHMIS CLASSIFICATION :

B2 - Flammable and combustible material - Reactive flammable material

WHMIS HEALTH EFFECTS :

Does not meet criteria

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 1% or greater

DETAILED WHMIS CLASSIFICATION ACCORDING TO CRITERIA :

CLASS A - COMPRESSED GAS: Does not meet criteria

CLASS B - FLAMMABLE & COMBUSTIBLE MATERIAL: Meets criteria for "Reactive flammable material"; fire hazard when wet; TDG class 4.3 (aluminum powder, uncoated).

CLASS C - OXIDIZING MATERIAL: Does not meet criteria

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 1 - IMMEDIATE AND SERIOUS TOXIC EFFECTS: Does not meet criteria

Acute lethality: Does not meet criteria

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 2 - OTHER TOXIC EFFECTS: Does not meet criteria. See detailed evaluation below.

CHRONIC HEALTH EFFECTS: Does not meet criteria

CARCINOGENICITY: Does not meet criteria; not in reference lists.

TERATOGENICITY and EMBRYOTOXICITY: Insufficient information

REPRODUCTIVE TOXICITY: Insufficient information

MUTAGENICITY: Does not meet criteria

RESPIRATORY TRACT SENSITIZATION: Does not meet criteria; not reported as human respiratory sensitizer.

SKIN IRRITATION: Does not meet criteria

EYE IRRITATION: Does not meet criteria

SKIN SENSITIZATION: Does not meet criteria . "

CLASS E - CORROSIVE MATERIAL: Does not meet criteria

CLASS F - DANGEROUSLY REACTIVE MATERIAL: Does not meet criteria

*** SECTION 16. OTHER INFORMATION ***

SELECTED BIBLIOGRAPHY :

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toxicology. 3rd revised ed. Vol. 2A : toxicology. John Wiley and Sons, Inc., 1981. p. 1493-1505

(2) Krueger, G.L., et al. The health effects of aluminum compounds in mammals. Critical Reviews in Toxicology. Vol. 13, no. 1 (1984). p. 1-24

(3) Sorenson, J.R.L., et al. Aluminum in the environment and human health. Environmental health perspectives. Vol. 6 (August 1974). p. 3-95

(4) Sarkar, B., ed. Biological aspects of metals and metal-related diseases. Raven Press, 1983. p. 207-218

(5) Field, F. Explosibility assessment of industrial powders and dusts. Her Majesty's Stationery Office, 1983

Information on chemicals reviewed in the CHEMINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHEMINFO records is available in the database Help.

REVIEW/PREPARATION DATE :

1986-07-30

REVISION INDICATORS :

PEL-TWA; 1993-03

NEPA (health); 1993-03

NEPA (flammability); 1993-03

NEPA (reactivity); 1993-03

WHMIS (proposed class); 1993-03

WHMIS (disclosure list); 1993-03

Trans PEL-TWA; 1993-04

TDG; 1994-02



Genium Publishing Corporation

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Material Safety Data Sheets Collection:

Sheet No. 297
Barium and Compounds

Issued: 4/90

Section 1. Material Identification

Barium and Compounds Description: Produced by reducing barium oxide with aluminum or silicon in a vacuum at high temperature. The minerals barite (BaSO_4) and witherite (BaCO_3) are the primary sources of barium. Used as lubricant for anode rotors in X-ray tubes; a deoxidizer for copper; an extender in paints; a loader for paper, soap, rubber, and linoleum; a carrier for radium; a fire extinguisher for uranium or plutonium fires; a rodenticide; a stabilizer and mold lubricant in the rubber and plastics industries; a flux for magnesium alloys; getter alloys in vacuum tubes; and in spark-plug alloys and Frary's metal. Important barium compounds include carbonate (ceramics, rodenticide), sulfate (pigment and filler), hydroxide (water treatment, ceramics), nitrate (pyrotechnics), chloride (chemicals), chromate (pigments), oxide (lubricants), and peroxide (bleach).

Other Designations: CAS No. 7440-39-3; Ba.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R 2
I 3
S 2
K 4

Gen
2 3
-

HM
H
F
R
PPC
* Se

Section 2. Ingredients and Occupational Exposure Limits

Barium, ca 100%

OSHA PEL

8-hr TWA: 0.5 mg/m³ (Barium, soluble compounds, as Ba)

NIOSH REL, 1987
None established

Toxicity Data*
None listed

ACGIH TLV, 1989-90

TLV-TWA: 0.5 mg/m³ (Barium, soluble compounds, as Ba)

* Monitor RTECS (CQ8370000) for additional future data.

Section 3. Physical Data*

Boiling Point: 2984 °F/1640 °C

Melting Point: 1337 °F/725 °C

Vapor Pressure: 10 mm Hg at 1920 °F/1049 °C

Molecular Weight: 137.33 g/mol

Specific Gravity ($\text{H}_2\text{O} = 1$ at 39 °F/4 °C): 3.51 at 68 °F/20 °C

Water Solubility: Insoluble

Appearance and Odor: A silver white metal that is slightly lustrous and somewhat malleable.

Comment: Barium has a distinctive property of absorbing gases.

* Physical data are for barium only.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Do not use water or foam. For small fires, use dry chemical, soda ash, lime, or sand. For large fires, withdraw from area and let fire burn.

Unusual Fire or Explosion Hazards: In the powder form, barium is flammable at room temperature. It is also explosive in the form of dust when exposed to heat, flame, or by chemical reaction. The chlorate, peroxide, and nitrate compounds are reactive and may present fire hazards in storage and use.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and fully encapsulating suit. Barium may ignite itself if exposed to air. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Barium is stable at room temperature under special storage and handling conditions (Sec. 9). If the free metal is exposed to air, an explosion hazard exists because hydrogen is liberated. Barium compounds are more stable than elemental barium. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Barium reacts violently with water, carbon tetrachloride, trichloroethylene, fluorotrichloromethane, and tetrachloroethylene. This material is incompatible with acids, trichloroethylene and water, trichlorotrifluoroethane, 1,1,2-trichloro trifluoro ethane, and fluorotrichloroethane. Barium is extremely reactive and reacts readily with halogens and ammonia. Barium compounds are not as reactive as elemental barium. See MSDSs 40, 119, 132, 173, 181, and 251 for specific chemical incompatibilities.

Conditions to Avoid: Avoid heating barium in hydrogen to about 392 °F/200 °C since it reacts violently and forms barium hydride (BaH_2). An explosion hazard exists if the free metal is exposed to moist air or cold water because hydrogen is liberated.

Section 6: Health Hazard Data

Carcinogenicity: Although the NTP, IARC, and OSHA do not list barium as a carcinogen, the IARC lists barium chromate (VI) as a carcinogen.

Summary of Risks: Barium presents mainly an explosion hazard. However, soluble compounds of barium by the oral route are highly toxic and the fatal dose of the chloride has been stated to be 0.8 to 0.9 g. Death may occur from a few hours to a few days. The soluble barium compounds exert a profound effect on skeletal, arterial, intestinal, bronchial, and particularly cardiac muscle. Effects on the hematopoietic system (responsible for the formation of blood or blood cells in the living body) and the cerebral cortex are also noted. Poisoning may also occur if the dust of soluble compounds is inhaled. Certain compounds of barium are irritants of the skin, eyes, and mucous membranes. Barium oxide and barium hydroxide, strongly alkaline in aqueous solution, cause severe skin irritation and burns of the eye. Inhalation of insoluble barium produces a benign pneumoconiosis (baritosis). The half-life of barium in bone has been estimated at 50 days.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Skin, eyes, mucous membranes, lung, heart.

Primary Entry Routes: Inhalation of dust or fume, ingestion, skin or eye contact.

Acute Effects: Systemic absorption from ingestion causes gastroenteritis (inflammation of the stomach lining and the intestines), slow pulse rate (heart may stop while contracting), muscle spasm, and hypokalemia (potassium deficiency in the blood). Inhalation causes coughing, bronchial irritation, and pneumoconiosis. Contact with soluble salts causes dermatitis, irritation of the eyes and mucous membranes, and burns. During radiological examination, intraperitoneal (in the abdomen) or intrathoracic (in the chest) barium sulfate contamination resulting from a complication rupture may cause a significant inflammatory response.

Chronic Effects: Although baritosis (caused by inhaling barium sulfate) produces nodular opacities on chest X-rays, there is no evidence of clinical illness or bodily dysfunction.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: Consider using calcium gluconate for muscular spasms. Consider gastric lavage followed by saline catharsis if soluble barium compounds are ingested. Institute cardiac monitoring for all significant ingestions of soluble barium salts.

Section 7: Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill. Immediately shut off all heat and ignition sources and evacuate hazard area. Cleanup personnel should protect against dust inhalation and contact with skin, eyes, and mucous membranes. For small dry spills, use a clean shovel to place material into a clean, dry container with a cover. For a large dry spill, cover with a plastic sheet to minimize spreading. For liquid spills, cover with sand or other noncombustible material and place in disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations *

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

*Designations for barium only.

Section 8: Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9: Special Precautions and Comments

Storage Requirements: Store under inert gas, petroleum, or oxygen-free liquid in a cool, dry, well-ventilated area away from all incompatibles (Sec. 5).

Engineering Controls: Barium metal itself presents mainly an explosion hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Use nonsparking tools. Proper storage is essential. Avoid dust inhalation and skin, eye, and mucous membrane contact. All processes should be enclosed and/or exhaust ventilation installed to keep the dust concentrations below the recommended levels. Practice good personal hygiene and housekeeping procedures. Preemployment and periodic medical examinations should be given to workers exposed to barite dust. Prevent exposing individuals with respiratory disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Barium alloys, pyrophoric

IMO Hazard Class: 4.2

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

ID No.: UN1854

MSDS Collection References: 7, 26, 38, 73, 85, 87, 89, 100, 103, 109, 123, 124, 126, 127, 133, 136, 138, 139

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Sheet No. 23
Cadmium Metal/Powder

Issued: 9/77

Revision: D, 5/93

Section 1. Material Identification

Cadmium Metal/Powder (Cd) Description: Occurs naturally in the mineral greenockite (cadmium sulfide). This form is rare and most cadmium is obtained by extraction from other ores containing it as a mineral (lead, copper, and zinc). Zinc sulfide ores are the main source; by direct distillation or recovery from the electrolytic process. Used in electroplating other metals, fire protection systems, nickel-cadmium storage batteries, power transmission wire, TV phosphors, pigments for ceramic glazes, machinery enamels, baking enamels, photography and lithography, selenium rectifiers, electrodes for cadmium-vapor lamps, and photoelectric cells; as a fungicide and a Weston standard cell control of atomic fission in nuclear reactors.

Other Designations: CAS No. 7440-43-9, colloidal cadmium.

Manufacturer: Contact your supplier/distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for suppliers list.

Cautions: Cadmium is a highly toxic metal. Symptoms may be delayed several hours and include pulmonary edema (fluid in lungs) which can be fatal. Chronic effects include kidney damage. Cd is considered a carcinogen by several government agencies. The powder is pyrophoric and presents a significant fire/explosion hazard.

Powder		
HMS	R	3
H	3*	I 4
F	1	S 2
R	3	K 3



Geni

Solid		
HMS	R	1
H	3*	I 4
F	0	S 2
R	0	K 1



*Chronic effects PPE-S

Section 2. Ingredients and Occupational Exposure Limits

Cadmium, ca 100%

1992 OSHA PEL

8-hr TWA: 5 µg/m³

1992 OSHA SECAL*

TWA: 15 or 50 µg/m³

1990 IDLH Level

50 mg/m³

1993-94 ACGIH TLVs

TWA: 0.01 mg/m³ (total dust), Class A2 carcinogen

TWA: 0.002 mg/m³ (respirable fraction)

1991 DFG (Germany) MAK

None established

1992 NIOSH REL

Carcinogen, keep as low as possible

1992 Toxicity Data†

Human, inhalation, LC₅₀: 39 mg/m³/20 min caused cardiac changes, thrombosis, and respiratory depression. Rat, oral, LD₅₀: 225 mg/kg; details not reported.

Woman, inhalation, LC₅₀: 129 µg/m³ for 20 continuous years produced lung tumors.

Man, TC₅₀: 88 µg/m³/8.6 years caused kidney and ur toxicity with protein in the urine.

* Separate engineering control limit: to be achieved in processes and work places where it is not possible to achieve the PEL through engineering and work practice alone. The SECAL for Cd is 15 or 50 µg/m³ depending on the processes involved. See Federal Register 57 (178): 42222, Table VIII-B1, 9/14/92.

† See NIOSH, RTECS (EU9800000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 1409 °F (765 °C)

Melting Point: 610 °F (321 °C)

Vapor Pressure: 0.095 mm Hg at 609.6 °F (320.9 °C)

Refraction Index: 1.13

Mohs Hardness: 2.0

Molecular Weight: 112.4

Density: 8.642

Water Solubility: Insoluble

Other Solubilities: Soluble in nitric (rapidly), hydrochloric (slowly), other acids. The solid is soluble in ammonium nitrate solution, but the powdered form undergoes an explosive reaction.

Appearance and Odor: Silver-white, blue-tinged, lustrous, odorless, soft metal that is easily cut with a knife. The powder is grayish-white.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: The solid metal is not flammable, but the finely divided powder is pyrophoric. As a rule, the more finely divided the powder is, the greater the potential for explosion. Use carbon dioxide, dry chemical, or sand. **Unusual Fire or Explosion Hazards:** Processes create cadmium dust such as cutting, grinding, or welding present a serious explosion hazard in presence of ignition sources. Avoid creation of cadmium dust clouds. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Cadmium easily tarnishes in moist air as it is oxidized to cadmium oxide. The solid is stable in dry air. The powder is pyrophoric. Cd becomes brittle at 176 °F (80 °C). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include ammonium nitrate (powdered Cd), hydrazoic acid, tellurium, zinc, ammonia, sulfur, selenium, nitryl fluoride, and oxidizing agents. **Conditions to Avoid:** Creation of Cd dust clouds, exposure to heat and ignition sources, and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidation decomposition of Cd can produce toxic cadmium oxide (CdO) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies list Cd as a carcinogen: IARC Class 2A (probably carcinogenic in humans),⁽¹⁸³⁾ NTP Class 2 (reasonably anticipated to be a carcinogen),⁽¹⁶⁹⁾ and NIOSH Class X (carcinogen defined without further categorization),⁽¹⁸³⁾ ACGIH TLV-A2 (suspected human carcinogen),⁽¹⁸³⁾ EPA-B1 (Probable human carcinogen) and DFG MAK-A2 (unmistakably carcinogenic in animal experimentation only).⁽¹⁸³⁾

Summary of Risks: Dust or fume inhalation generally results in acute symptoms delayed up to 24 hr. Effects include a flu-like syndrome similar to metal fume fever with chills, fever, and muscle pain in the back and limbs. Pulmonary edema (fluid in lungs) can develop after severe exposure and may result in death. If victim recovers, residual changes may include lung fibrosis (thickening) and vascular changes. Long-term exposure to Cd damages the liver and kidneys (accumulates, half-life = 7 to 30 yr). Proteinuria (protein in urine) of low molecular weight is the first sign of tubular dysfunction. Excess urinary glucose is also seen. Bone demineralization similar to osteoporosis (decreased bone density)...

Continue on next page

Section 6. Health Hazard Data, continued

occurs *not* as a direct effect of Cd exposure, but indirectly by altering kidney regulation of calcium and phosphorus which are needed for strong, healthy bones. Some studies show a correlation between anemia (low hemoglobin in blood) and high Cd levels. Selenium (Se) and zinc (Zn) appear to suppress Cd toxicity; Se binds up Cd, preventing it from entering body tissue and Zn may compete for the same metabolic site. **Medical Conditions Aggravated by Long-Term Exposure:** Kidney, blood, or respiratory disorders. **Target Organs:** Blood, kidney, liver, respiratory system. **Primary Entry Routes:** Inhalation, ingestion. **Acute Effects:** Inhalation may cause irritation of the eyes, nose, and throat, nausea and vomiting, abdominal colic, diarrhea, chest tightness, cough, headache, and weakness. Pulmonary edema could develop up to 24 hr post exposure. Kidney damage may occur after acute exposures, but is more likely with chronic exposure. **Chronic Effects:** Symptoms may be delayed several years after last exposure and include perforation of the nasal septum (tissue between the nostrils), loss of smell, chronic bronchitis, severe progressive emphysema, anorexia, insomnia, fatigue, pallor, anemia, kidney damage, bone demineralization, lung fibrosis and possible cancer of the respiratory tract.

FIRST AID

Eyes: Do *not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Wash exposed area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. Do *not* induce vomiting because of cadmium's irritating nature.

Note to Physicians: 8-2 microglobulin excretion of > 200 µg/g creatinine indicates kidney dysfunction as does a renal cortex [Cd] of 180 to 220 µg/g of wet kidney cortex. Blood Cd levels are *not* indicative of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation. Carefully scoop up small spills and place in sealed impermeable containers. Do *not* disperse dust by sweeping. Remember that Cd powder can be pyrophoric and must be handled carefully. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.24): D006, Characteristic of Toxicity; regulatory level = 1.0 mg/L

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg)† [* per CWA, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1027)

† No reporting of releases of this substance is required if the diameter of the pieces of the solid metal is equal to or exceeds 100 µm (0.004 in.)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied air respirator (with auxiliary SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.** If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear gloves, boots, aprons, and gauntlets to prevent Cd dust from contacting skin. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL or SECAL (Sec. 2). Lunchroom facilities should not have concentrations above 2.5 µg/m³ at any time. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes; launder before reuse. Remove Cd from shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Cd, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Do *not* allow cadmium dust to build up in storage area.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Prohibit workers from removing Cd from protective clothing and equipment by blowing, shaking, or any other means that disperses Cd into the air. Employees must not enter eating facilities while wearing PPE unless it is vacuumed with a HEPA. Consider preplacement and periodic medical exams of exposed workers emphasizing the blood, kidneys, liver, and respiratory system. Educate workers on Cadmium's carcinogenicity.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Poisonous solids, n.o.s.*

Pyrophoric metals, n.o.s.†

DOT Hazard Class: 6.1*, 4.2†

ID No.: UN2811*, UN1383†

DOT Packing Group: III*, I†

DOT Label: Keep away from food*, Spontaneously Combustible†

Special Provisions (172.102): —*, B11†

* Solid metal, † Powder

Packaging Authorizations

a) Exceptions: 173.153*, None†

b) Non-bulk Packaging: 173.213*, .187†

c) Bulk Packaging: 173.240*, .242†

Quantity Limitations

a) Passenger Aircraft or Railcar: 100 kg*, Forbidden†

b) Cargo Aircraft Only: 200 kg*, Forbidden†

Vessel Stowage Requirements

a) Vessel Stowage: A*, D†

b) Other: —

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 159, 167, 169, 183, 185, 186

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 22
Calcium Oxide

Issued: 9/78

Revision: D, 9/92

Section 1. Material Identification

Calcium Oxide (CaO) Description: Derived by kiln roasting limestone (CaCO_3) at 2762 °F (1517 °C) to drive off the carbon dioxide (CO_2). Used in manufacture of aluminum, magnesium, steel, glass, paper, industrial chemicals, mortar, plaster, and chlorinated lime for bleaching; in fungicides, insecticides, lubricants and flotation of non-ferrous ores; as a scrubbing agent to remove sulfur dioxide emissions from smoke stacks; for clarification of beet and cane sugars, dehairing hides for leather and for water and sewage treatment.

Other Designations: CAS No. 1305-78-8, burnt lime, calcia, calx, lime, pebble lime, quicklime, unslaked lime.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R	1	NF
I	3	
S	3	
K	0	

HM
H
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ef
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Cautions: Calcium oxide dust is irritating and forms corrosive calcium hydroxide when in contact with moist body surfaces or with water. Serious burns or sight loss may result if treatment is not immediate. The crystal form is less reactive with water than the powder which can generate temperatures as high as 1470 °F (800 °C).

Section 2. Ingredients and Occupational Exposure Limits

Calcium Oxide, ca 95%; impurities include calcium carbonate, cobalt, nickel, magnesium, iron, aluminum oxide, and crystalline silica.

1991 OSHA PEL
8-hr TWA: 5 mg/m³

1990 NIOSH REL
10-hr TWA: 2 mg/m³

1992-93 ACGIH TLV
TWA: 2 mg/m³

1990 DFG (Germany) MAK
TWA: 5 mg/m³

1985-86 Toxicity Data:
None reported

Category I: local irritants

* Monitor NIOSH, RTECS (EW3100000), for future data.

Section 3. Physical Data

Boiling Point: 5162 °F (2850 °C)
Melting Point: 4737 °F (2614 °C)
Vapor Pressure: ~0 mm Hg
pH: 11.7 to 12.5
Molecular Weight: 56.1

Specific Gravity: 3.37 at 77 °F (25 °C)

Water Solubility: Reacts exothermically to form caustic calcium hydroxide solution. 1g dissolves in 835 mL at 77 °F (25 °C), 1g/167(mL at 212 °F (100 °C)

Other Solubilities: Soluble in acids, glycerol, and sugar solution.

Appearance and Odor: Odorless crystals, white or grayish-white lumps, or granular powder. Commercial brands may have a yellow or brown due to iron content. It becomes incandescent when heated near its melting point.

Section 4. Fire and Explosion Data

Flash Point: Noncombustible

Autoignition Temperature: Noncombustible

LEL: None reported

UEL: None reported

Extinguishing Media: Calcium oxide is noncombustible but in contact with water can generate sufficient heat to ignite other combustibles (v ignition of sulfur, straw, gunpowder, and wood are reported). To fight fires use dry chemical, fog, or foam. *Do not* use carbon dioxide or halogenated agents (i.e., Halon). Use water only if there is enough to flood fire and absorb all heat generated by the calcium oxide + water reaction.

Unusual Fire or Explosion Hazards: Calcium oxide crystals react slowly with water but the powder can explode violently. Bulk dust may be spontaneously becoming only slightly damp. Use water carefully around calcium oxide!

Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide or limited protection. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Calcium oxide will react with water (forming calcium hydroxide) and carbon dioxide [forming calcium carbonate (chalk)] if exposed to air. Containers can swell and burst if moisture gets in. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Reacts with water to form calcium hydroxide and heat [(up to 1470 °F (800 °C)], with carbon dioxide to form calcium carbonate (chalk). Incompatible with ethanol, boric oxide + calcium chloride, and interhalogens such as boron trifluoride, chlorine trifluoride, fluorine, hydrofluoric acid, phosphorus pentoxide, perchlorates, nitrates, and permanganates.

Conditions to Avoid: Avoid excessive dust generation, exposure to air (water and carbon dioxide) and other incompatibles.

Hazardous Products of Decomposition: None known.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,⁽¹⁶⁴⁾ NTP,⁽¹⁶⁹⁾ and OSHA⁽¹⁶⁴⁾ do not list calcium oxide as a carcinogen. One of calcium oxides' impurities, crystalline silica is considered an IARC Class A-2 (sufficient animal evidence, insufficient human evidence) and a NIOSH Class X (carcinogen with no firm classification) carcinogen.

Summary of Risks: Calcium oxide powder is highly corrosive to moist skin, eyes, and mucous membranes of the digestive and respiratory tract. Irritant and corrosive effects are due to the formation of alkaline calcium hydroxide when it contacts water/moisture. If treatment is not immediate permanent damage can result.

Medical Conditions Aggravated by Long-Term Exposure: Possibly, bronchitis or other chronic respiratory problems. **Target Organs:** Eye, skin, nails, respiratory system. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Dust inhalation can cause upper respiratory tract inflammation and irritation (lower respiratory tract is usually only affected at high concentrations).

Continue on next

Section 6. Health Hazard Data

pneumonia, nasal septum perforation, cough, sneezing, and risk of pulmonary edema (fluid in lungs). Skin contact causes itching and if skin is moist symptoms include a slippery, soapy feeling, burning, ulceration, irreparable tissue damage, and state of shock. Ingestion causes immediate, intense burning in the mouth, throat and stomach (white color of mouth mucous membranes), throat swelling, increased salivation and drooling, vomiting (coffee grounds like material due to digestive hemorrhage), stomach cramps, state of shock, diarrhea (possibly blood stained), risk of stomach perforation, unconsciousness, and death. Eye contact produces severe irritation and burns, watering, eye and lid perforation, eyesight or eye loss. **Chronic Effects:** Repeated inhalation of small amounts can cause perforation of the nasal septum (tissue between nostrils), and repeated skin contact can cause dermatitis and fissuring with brittleness and cracking of the nails.

FIRST AID

Eyes: Do not allow victim to rub or keep eyes tightly shut. Immediate treatment is necessary; if only one eye is contaminated but first aid is not immediate, the other eye may be lost as well even though the CaO has not contacted it! Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility; pay close attention to the conjunctival sacs where CaO tends to form clumps. Consult an ophthalmologist immediately. **Skin:** Quickly remove contaminated clothing. Rinse with flooding amounts of water until slippery-soapy feeling disappears (may take >1 hr). Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that conscious and alert person drink 1 to 2 glasses of water or milk to dilute. Do not induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Immediate treatment is necessary.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and skin/eye contact. Water spray may be used to control dust but measures should be taken to control the resulting heat that will generate. For small spills, do not dry sweep! Scoop spill into suitable container and damp mop residues or vacuum (with a high efficiency particulate filter). For large spills, contain material - waste lime may be used for neutralization of waste acids. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Mosquito fish, TLM = 240 ppm/24 hr; Sunfish, 100 ppm/3 hr is toxic; vector snail, 300 ppm/24 hr is lethal. **Disposal:** In situ amelioration - neutralize with sodium hydrogen carbonate or carbon dioxide. Consider using waste lime for neutralizing facility acid wastes. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. D003, Characteristic of corrosivity

Listed as a CERCLA Hazardous Substance, "Unlisted Hazardous Waste, Characteristic of corrosivity"* (40 CFR 302.4): Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001]

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 10 mg/m³, use a dust mask. For < 50 mg/m³ use any powered, air purifying respirator with a high efficiency particulate filter or supplied-air respirator (SAR). For < 100 mg/m³, use any SCBA or SAR with a full facepiece. For < 250 mg/m³, use any SAR operated in pressure-demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.** If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl, rubber, or neoprene or suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in glass rather than plastic containers, in a cool, dry, well-ventilated area away from incompatibles (Sec. 5). Periodically inspect containers for cracks. Keep CaO containers out of reach from safety showers or sprinkler systems because of the dangerous reaction that occurs when CaO contacts water. CaO is not combustible but when contacting water it may generate sufficient heat to ignite other combustibles. Thus, keep CaO away from combustibles and water sources such as safety showers and sprinkler systems. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to keep levels as low as possible. **Enclose processes and automatically transfer CaO from drums or other storage containers to process containers.** CaO may be corrosive to some equipment and cause excessive scaling. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the skin, eyes, and respiratory tract (including lung function tests, FEV & FVC).

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Calcium Oxide

DOT Hazard Class: 8

ID No.: UN1910

DOT Packaging Group: III

DOT Label: Corrosive

Special Provisions (172.102): --

Packaging Authorizations

a) Exceptions: 173.154

b) Non-bulk Packaging: 173.213

c) Bulk Packaging: 173.240

Vessel Stowage Requirements

a) Vessel Stowage: A

b) Other: --

Quantity Limitations

a) Passenger, Aircraft, or Railcar: 25 kg

b) Cargo Aircraft Only: 100 kg

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 149, 153, 159, 163, 164, 167, 180

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* C H E M I N F O *
*
* Canadian Centre for Occupational Health and Safety *

*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 547
CCOHS CHEMICAL NAME : Chromium
SYNONYMS :
* Chrome
* Elemental chromium
* Chromium metal
CAS REGISTRY NUMBER : 7440-47-3
RTECS NUMBER(S) : GB4200000
CHEMICAL FAMILY : Elemental chromium
MOLECULAR FORMULA : Cr
STRUCTURAL FORMULA : Cr

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :

Steel-grey, lustrous metal; odourless (3); available as lumps, granules, powder or high purity single crystals.(2)

ODOUR THRESHOLD :

Not applicable

WARNING PROPERTIES :

Not applicable

COMPOSITION/PURITY :

Chromium occurs as chromium metal (elemental chromium) and as chromium compounds (for example, chromous, chromic and chromate compounds). This record contains information only on chromium metal. There are CHEMINFO records on a number of chromium compounds. NOTE: Many publications describe various toxic effects and properties of "chromium". In most cases the information applies to chromium compounds in general, and not to chromium metal.

USES AND OCCURRENCES :

Component of stainless steels and high temperature alloys; coating on metal and plastic (electroplated from solutions of chromium salts); synthesis of inorganic pigments (2); manufactured metal goods.

*** SECTION 3. HAZARDS IDENTIFICATION ***

** POTENTIAL HEALTH EFFECTS **

EFFECTS OF SHORT-TERM (ACUTE) EXPOSURE :

INHALATION :

Chromium metal dust appears to have low toxicity by all routes of occupational exposure. There is very little published information on the toxic effects of chromium metal, but the metal is practically insoluble and unreactive in the body. However, exposure to metal dust usually occurs during operations such as cutting, grinding and welding, which often involve exposure to hazardous dusts and fumes of chromium compounds and other materials. Chromium dust can probably cause coughing and mild temporary irritation (non-specific dust effects).

SKIN CONTACT :

Dust is not irritating to the skin, but use of rigorous washing procedures

to remove dust may cause skin irritation.

EYE CONTACT :

Chromium metal dust is not irritating to the eyes except as a "foreign object".(6) Some tearing, blinking and mild temporary pain may occur as particles are rinsed from the surface of the eye.

INGESTION :

Metallic chromium probably is practically non-toxic by ingestion and is not absorbed into the body. It probably can be slowly oxidized to trivalent chromium compounds by stomach acids, but trivalent chromium has low toxicity and is poorly absorbed. Almost all of the chromium probably is eliminated in feces.

EFFECTS OF LONG-TERM (CHRONIC) EXPOSURE :

SKIN: Metallic chromium probably does not cause irritation or sensitization. Some chromium compounds (primarily hexavalent chromium) can cause sensitization (chrome allergy).(8)

INHALATION: Pulmonary disease was reported in workers exposed to dust containing chromium metal and ferrichrome alloys, but also containing other dusts and fumes. Exposure to chromium metal dust does not give rise to lung disease (pulmonary fibrosis or pneumoconiosis).(9) Chromium metal has not been reported as a respiratory sensitizer.

CARCINOGENICITY :

No adequate human or animal information is available.(1,12) Overall IARC evaluation of carcinogenic risk: Group 3 (not classifiable).(12)

TERATOGENICITY AND EMBRYOTOXICITY :

No human or animal information available. No embryotoxic or teratogenic effects are likely.

REPRODUCTIVE TOXICITY :

No information available

MUTAGENICITY :

No information available

TOXICOLOGICALLY SYNERGISTIC MATERIALS :

No information available

POTENTIAL FOR ACCUMULATION :

Chromium dust can accumulate in the lungs.

HEALTH COMMENTS :

Interpretation of the available information is complicated by mixed exposures. Therefore, it is difficult to state conclusively that chromium metal has no significant toxic effects.

***** SECTION 4. FIRST AID MEASURES *****

INHALATION :

If symptoms are experienced, remove source of contamination or move victim to fresh air. Obtain medical advice immediately.

SKIN CONTACT :

If irritation occurs, wash gently and thoroughly with water and non-abrasive soap.

If irritation persists, obtain medical advice immediately.

EYE CONTACT :

If irritation occurs, immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 10 minutes, by the clock, holding the eyelid(s) open.

If irritation persists, repeat flushing.

Obtain medical advice immediately.

INGESTION :

Have victim rinse mouth thoroughly with water.

DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz.) of water.

If vomiting occurs naturally, rinse mouth and repeat administration of water.

Obtain medical advice immediately.

FIRST AID COMMENTS :

All first aid procedures should be periodically reviewed by a physician familiar with the material and its conditions of use in the workplace.

***** SECTION 5. FIRE FIGHTING MEASURES *****

FLASH POINT :

Not applicable (does not form vapour)

LOWER FLAMMABLE (EXPLOSIVE) LIMIT (LFL/LEL) :

0.23 g/L (dust cloud) (13)

UPPER FLAMMABLE (EXPLOSIVE) LIMIT (UFL/UEL) :

Not available

AUTOIGNITION (IGNITION) TEMPERATURE :

Not applicable

EXPLOSION DATA - SENSITIVITY TO MECHANICAL IMPACT :

Not sensitive; stable material.

EXPLOSION DATA - SENSITIVITY TO STATIC CHARGE :

Powdered chromium metal is probably not sensitive to static discharge.

COMBUSTION AND THERMAL DECOMPOSITION PRODUCTS :

Oxides of chromium

FIRE HAZARD COMMENTS :

When heated in a flame, chromium dust may be ignitable.(5) Minimum ignition temperature, cloud: 580 deg C; layer: 400 deg C.(13)

EXTINGUISHING MEDIA :

Use extinguishing agents appropriate for surrounding fire. Do not use carbon dioxide, which may form an explosive mixture with powdered chromium.(11)

FIRE FIGHTING INSTRUCTIONS :

Chromium dust will not burn unless heated in a flame.(5)

***** SECTION 6. ACCIDENTAL RELEASE MEASURES *****

PRECAUTIONS :

(Dust or powder): Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. Wear adequate personal protective equipment. Extinguish or remove all ignition sources. Notify government occupational health and safety and environmental authorities.

CLEAN-UP :

Avoid generating dust. Use vacuum equipped with HEPA filter(s). Alternatively, shovel into clean, dry, labelled containers and cover. Flush area with water.

***** SECTION 7. HANDLING AND STORAGE *****

HANDLING :

Avoid generating dust.

Label containers. Keep containers closed when not in use. Empty containers may contain residues which are hazardous.

STORAGE :

(Recommendations for chromium powder or dust. Some recommendations may also apply to other forms of chromium metal.)

Store in a dry, well-ventilated area.

Store away from incompatible materials such as oxidizing materials.

Store in suitable, labelled containers. Keep containers tightly closed when not in use and when empty. Protect from damage.

Avoid any dust build-up by frequent cleaning and suitable construction of storage area.

*** SECTION 6. EXPOSURE CONTROLS/PERSONAL PROTECTION ***

NOTE : Exposure to this material can be controlled in many ways. The measures appropriate for a particular worksite depend on how this material is used and on the extent of exposure. This general information can be used to help develop specific control measures. Ensure that control systems are properly designed and maintained. Comply with occupational, environmental, fire, and other applicable regulations.

SAMPLING AND ANALYSIS :

Use appropriate instrumentation and sampling strategy (location, timing, duration, frequency, and number of samples). Interpretation of the sampling results is related to these variables and the analytical method. NIOSH METHOD(S): 7300 (elements by ICP) - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 1; 7200 (welding & brazing fume) - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 2; 7024 (chromium and compounds, as Cr) - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 1

ENGINEERING CONTROLS :

Engineering methods to control hazardous conditions are preferred. Methods include mechanical (local exhaust) ventilation, process or personnel enclosure and control of process conditions. Administrative controls and personal protective equipment may also be required. Use local exhaust ventilation, and process enclosure if necessary, to control airborne dust. Use a non-sparking, grounded ventilation system separate from other exhaust ventilation systems when handling chromium dust. Exhaust directly to the outside. Locate dust collectors outside or where permitted by regulation. Supply sufficient replacement air to make up for air removed by exhaust system.

PERSONAL PROTECTIVE EQUIPMENT :

If engineering controls and work practices are not effective in controlling exposure to this material, then wear suitable personal protective equipment including approved respiratory protection. Have appropriate equipment available for use in emergencies such as fire. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection. Refer to the CSA Standard Z94.4-93, "Selection, Care, and Use of Respirators," available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

RESPIRATORY PROTECTION GUIDELINES :

NIOSH RECOMMENDATIONS FOR CHROMIUM METAL CONCENTRATIONS IN AIR (14):

UP TO 2.5 mg/m³: Dust and mist respirator.

UP TO 5 mg/m³: Dust and mist respirator except single-use and quarter-mask respirator; or SAR; or SCBA.

UP TO 12.5 mg/m³: Powered air-purifying respirator with dust and mist filter(s); or SAR operated in a continuous-flow mode.

UP TO 25 mg/m³: Full-facepiece respirator with high-efficiency particulate filter(s); or powered air-purifying respirator with tight-fitting facepiece and high-efficiency particulate filter(s); or full-facepiece SCBA; or full-facepiece SAR.

UP TO 500 mg/m³: Positive pressure, full-facepiece SAR.

EMERGENCY OR PLANNED ENTRY INTO UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS:

Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

ESCAPE: Full-facepiece respirator with high-efficiency particulate

filter(s); or escape-type SCBA.

NOTE: No evidence can be found for the existence of an IDLH.

NOTE: Substance reported to cause eye irritation or damage; may require eye protection.

ABBREVIATIONS: SAR = supplied-air respirator; SCBA = self-contained breathing apparatus. IDLH = Immediately Dangerous to Life or Health.

NOTE: In these recommendations, the IDLH concentration is defined as the maximum concentration which would not cause any escape-impairing symptoms or irreversible health effects to a person exposed for 30 minutes if the respirator failed.

Recommendations apply only to NIOSH and MSHA (Mine Safety and Health Administration) approved respirators.

Air-purifying respirators do not protect against oxygen-deficient atmospheres.

EYE/FACE PROTECTION :

No specific requirement, but it is good practice to wear chemical safety goggles.

SKIN PROTECTION :

No specific requirement, but it is good practice to prevent skin contact.

RESISTANCE OF MATERIALS FOR PROTECTIVE CLOTHING :

No specific guidelines are available. Most materials commonly used in protective clothing are probably adequate. Contact the manufacturer or supplier for specific advice.

EXPOSURE CONTROLS/PERSONAL PROTECTION COMMENTS :

Do not eat, smoke or drink in work areas. Wash hands thoroughly after handling this material. Maintain good housekeeping.

** EXPOSURE GUIDELINES **

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF
GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 1993-94 *

TIME-WEIGHTED AVERAGE (TLV-TWA) : (0.5 mg/m³)*

TLV COMMENTS :

*NOTICE OF INTENDED CHANGE: The designation as "Not Classifiable as a Human Carcinogen (A4)" has been proposed.

CARCINOGEN A4 - Not Classifiable as a Human Carcinogen: Inadequate data on which to classify the substance as a human and/or animal carcinogen.

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 1 mg/m³ (as Cr)

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 0.5 mg/m3 (Chromium, sol. chromic, chromous salts - as Cr); 1 mg/m3 (Chromium, metal and insoluble salts - as Cr)

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 52.00
CONVERSION FACTOR :
Not applicable
MELTING POINT : 1900 deg C (3452 deg F)
BOILING POINT : 2642 deg C (4786 deg F)
RELATIVE DENSITY (SPECIFIC GRAVITY) :
7.2 (water = 1)
SOLUBILITY IN WATER :
Not soluble
SOLUBILITY IN OTHER LIQUIDS :
Not soluble in organic solvents or bases. Soluble in halogens and halogen acids (e.g. hydrochloric acid) and dilute sulphuric acid (reacts).
VAPOUR DENSITY : Not applicable
VAPOUR PRESSURE : Practically zero at room temperature
SATURATION VAPOUR CONCENTRATION : Not applicable
EVAPORATION RATE : Not applicable
pH VALUE : Not applicable
CRITICAL TEMPERATURE : Not applicable
COEFFICIENT OF OIL/WATER DISTRIBUTION (PARTITION COEFFICIENT) :
Not applicable

*** SECTION 10. STABILITY AND REACTIVITY ***

STABILITY :
Stable material
HAZARDOUS POLYMERIZATION :
Does not occur
HAZARDOUS DECOMPOSITION PRODUCTS :
None
INCOMPATIBILITY - MATERIALS TO AVOID :
OXIDIZING AGENTS - powdered chromium becomes incandescent.(10)
CARBON DIOXIDE - a heated mixture of chromium powder and carbon dioxide may be ignitable and explosive. Bulk metal may burn in the presence of carbon dioxide.(11)
CORROSIVITY TO METALS :
Not corrosive

*** SECTION 11. TOXICOLOGICAL INFORMATION ***

EYE IRRITATION (rabbit): Chromium metal implanted into rabbits' eyes was tolerated well while under observation for one year.(6)
CARCINOGENICITY: In a series of studies, rats were injected with powdered chromium. The number of tumours was not significantly greater in the test animals than in controls. Similar results were observed in experiments with mice. When tested on rabbits, one of three animals developed a tumour.(1)
IARC evaluation of the carcinogenicity of chromium metal to experimental animals: inadequate evidence.(12)

*** SECTION 12. ECOLOGICAL INFORMATION ***

NOTE : This section is under development.

*** SECTION 13. DISPOSAL CONSIDERATIONS ***

Review federal, provincial and local government requirements prior to disposal. Store material for disposal as indicated in Storage Conditions. Disposal of dust or powder by secure landfill may be acceptable. Recycling of metal is preferred.

*** SECTION 14. TRANSPORT INFORMATION ***

** TRANSPORTATION OF DANGEROUS GOODS (TDG) SHIPPING INFORMATION **

This chemical is not specifically listed in the Canadian Transportation of Dangerous Goods Regulations. However it may be regulated as a part of a chemical family or group Not Otherwise Specified (N.O.S.) (e.g. LIQUID DYES N.O.S.). Consult the regulation.

NOTE: This information incorporates Schedule No. 18 amendments to the Transportation of Dangerous Goods Act, 1992, effective October 1, 1994.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

PROPOSED WHMIS CLASSIFICATION :

Insufficient information

WHMIS HEALTH EFFECTS :

Insufficient information

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 0.1% or greater

DETAILED WHMIS CLASSIFICATION ACCORDING TO CRITERIA :

CLASS A - COMPRESSED GAS: Does not meet criteria

CLASS B - FLAMMABLE & COMBUSTIBLE MATERIAL: Does not meet criteria

CLASS C - OXIDIZING MATERIAL: Does not meet criteria

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 1 - IMMEDIATE AND SERIOUS TOXIC EFFECTS: Insufficient information for classification

Acute Lethality: Insufficient information

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 2 - OTHER TOXIC EFFECTS: Insufficient information for classification

CLASS E - CORROSIVE MATERIAL: Does not meet criteria

CLASS F - DANGEROUSLY REACTIVE MATERIAL: Does not meet criteria

*** SECTION 16. OTHER INFORMATION ***

SELECTED BIBLIOGRAPHY :

(1) IARC Monographs on the evaluation of the carcinogenic risk of chemicals to humans. Vol. 23. IARC, 1980. p. 205-323

(2) Hawley's condensed chemical dictionary. 11th ed. Van Nostrand Reinhold, 1987. p. 280

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(6) Grant, W.M. Toxicology of the eye. 3rd ed. Charles C. Thomas,

1986. p. 234

(7) Grant, W.M. Toxicology of the eye. Vol. 1. 2nd ed. Charles C. Thomas, 1974. p. 290

(8) Handbook on the toxicology of metals. Elsevier/North-Holland Biomedical Press, 1979. p. 383-397

(9) Documentation of the threshold limit values and biological exposure indices. 5th ed. ACGIH, 1986. p. 139-140

(10) Fire protection guide on hazardous materials. 9th ed. National Fire Protection Association, 1986. p. 491B-66

(11) Bretherick, L. Handbook of reactive chemical hazards. 3rd ed. Butterworths, 1985. p. 192

(12) IARC monographs on the evaluation of carcinogenic risks to humans. Supplement 7. IARC, 1987

(13) Fire protection handbook. 16th ed. National Fire Protection Association, 1986. p. 5-99 - 5-100

(14) NIOSH pocket guide to chemical hazards. NIOSH, June 1990. p. 70-71

Information on chemicals reviewed in the CHENINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHENINFO records is available in the database Help.

REVIEW/PREPARATION DATE :

1989-10-25

REVISION INDICATORS :

PEL-TWA: 1993-03

WHMIS (disclosure list): 1993-03

Trans PEL-TWA: 1993-04

TLV comments: 1993-12

TDS: 1994-02

C H E M I N F O
*
* Canadian Centre for Occupational Health and Safety *

*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 546
CCOHS CHEMICAL NAME : Copper
SYNONYMS :
* Cuivre
* C.I. Pigment metal 2
CAS REGISTRY NUMBER : 7440-50-8
RTECS NUMBER(S) : GL5325000
CHEMICAL FAMILY : Inorganic copper compound / group 18 metal element
MOLECULAR FORMULA : Cu
STRUCTURAL FORMULA : Cu

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :
Reddish, lustrous metal; odourless.
ODOUR THRESHOLD :
Not applicable
WARNING PROPERTIES :
Insufficient information for evaluation.
COMPOSITION/PURITY :
Commercial grades are at least 99% pure; special electrical grades may exceed 99.999% purity. Copper may contain trace amounts of other elements such as arsenic, antimony, bismuth, selenium, tellurium, zinc, mercury, gold and silver.(6)
USES AND OCCURRENCES :
Used in alloys (bronze, brass); electrical conductors; construction materials (plumbing, roofing); ammunition; preparation of copper salts; works of art; electroplating; pesticide manufacture.(1,2)

*** SECTION 3. HAZARDS IDENTIFICATION ***

** POTENTIAL HEALTH EFFECTS **

EFFECTS OF SHORT-TERM (ACUTE) EXPOSURE :
INHALATION :

Copper dust may cause temporary irritation of the nose and throat. METAL FUME FEVER occurs when freshly formed copper fumes (primarily copper oxide) are inhaled. Extremely fine copper dust may also cause this disease. Symptoms develop in 6 to 48 hours and include headache, metallic taste in the mouth, cough, thirst, throat irritation, shortness of breath, fever, sweating and pains in the legs and chest. The illness is not fatal and recovery occurs within two days. No permanent effects are known. Metal fume fever has been reported at concentrations of 0.1 mg/m³ copper.(10) Studies in British copper refining operations indicate that no ill effects occur at copper fume concentrations below 0.4 mg/m³.(14) Since the vapourization (boiling) point of copper is high (2595 deg C), it is rare that these fumes are encountered in industry.(11) Finely divided copper dust is more commonly encountered. Some of the ill effects arising from working with copper may be caused by contamination of copper by metals such as arsenic and lead.(11)

SKIN CONTACT :

Metallic copper does not injure the skin, except that it can cause mechanical abrasion. Imbedded particles can cause inflammation of the nerves if imbedded in the skin.(11) No specific information is available, but copper metal is not likely to be absorbed through the skin.

EYE CONTACT :

Copper dust is not irritating to the surface of the eye except as a "foreign body". Blinking and tearing may occur as the particles are washed from the surface of the eye. Copper particles can penetrate the eye if projected from a grinding wheel or exploding casing. The imbedded copper particles can cause bleeding and rapid formation of an abscess. Greenish-brownish discolouration of the eye may occur. Blindness could result. Severity of injury depends primarily on size and location of foreign body in the eye. In rare cases, glaucoma (increased pressure in the eye which could lead to blindness) may develop.(8)

INGESTION :

Copper is a required nutrient and concentrations in the body are usually kept in balance.(10) The toxicity of metallic copper is dependent on the acidity of the stomach and the amount ingested. Symptoms of poisoning may include metallic taste in the mouth, salivation, nausea, vomiting, stomach ache, diarrhea, degeneration of blood and liver cells, gastro-intestinal bleeding, decreased urine output, listlessness, rapid heartbeat, convulsions, coma and death.(11) About 60% of copper ingested, as salt, is absorbed and most is excreted in the feces.(10) It is extremely unlikely that toxic concentrations would be ingested in a work environment.

EFFECTS OF LONG-TERM (CHRONIC) EXPOSURE :

INHALATION: Nasal ulceration and perforation due to inhalation of copper have been reported.(11) These effects may be attributable to trace contamination by sulphuric acid.

A worker exposed for six years to copper dust at 0.066 to 0.104 mg/m³ experienced diarrhea and vomiting. Others exposed to 0.75 to 1.20 mg/m³ experienced general tiredness and head stuffiness.(11)

SKIN SENSITIZATION: Rare cases of allergic contact dermatitis have been reported in people working with copper dust.(16)

Wilson's disease, a hereditary copper storage illness, has not been reported as a result of chronic industrial exposure to copper.(11)

Copper may act in conjunction with other chemical agents or personal physical predispositions, to produce, in some workers, an illness similar to Wilson's disease.(11) Symptoms may include kidney and liver disorder and discolouration of the skin and eyes.(8,11)

CARCINOGENICITY :

No human information. Animal studies suggest that copper does not cause cancer.

TERATOGENICITY AND EMBRYOTOXICITY :

No human information available. Animal tests are inconclusive.

REPRODUCTIVE TOXICITY :

No information available

MUTAGENICITY :

No information available

TOXICOLOGICALLY SYNERGISTIC MATERIALS :

No information available

POTENTIAL FOR ACCUMULATION :

Copper, in the form of various copper compounds, is an essential nutrient and concentration is normally balanced in the body. Copper compounds are normally excreted in the feces, sweat and to a small extent, the urine. Accumulation in the hair, nails, skin, eyes, liver, muscles and brain can occur.(6)

*** SECTION 4. FIRST AID MEASURES ***

INHALATION :

If symptoms are experienced, remove source of contamination or move victim to fresh air. If symptoms persist or develop within 48 hours, obtain medical advice immediately.

SKIN CONTACT :

If irritation occurs, gently blot or brush away excess chemical quickly. Wash gently and thoroughly with water and non-abrasive soap.

If particle is lodged under the skin, obtain medical attention immediately.

EYE CONTACT :

Immediately flush the contaminated eye(s) with lukewarm, gently flowing water, holding the eyelid(s) open, until particles have been removed.

If irritation persists, or if any particles cannot be removed by gently washing, do not attempt any further methods of removal. Cover both eyes with a clean, dry patch and transport victim to an emergency medical facility.

INGESTION :

Have victim rinse mouth thoroughly with water.

DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz.) of water.

If vomiting occurs naturally, rinse mouth and repeat administration of water.

Obtain medical attention immediately.

FIRST AID COMMENTS :

Consult a physician and/or the nearest Poison Control Centre for all exposures except minor instances of inhalation or skin contact. All first aid procedures should be periodically reviewed by a physician familiar with the material and its conditions of use in the workplace.

*** SECTION 5. FIRE FIGHTING MEASURES ***

FLASH POINT :

Not applicable. Does not burn.

LOWER FLAMMABLE (EXPLOSIVE) LIMIT (LFL/LEL) :

Not applicable

UPPER FLAMMABLE (EXPLOSIVE) LIMIT (UFL/UEL) :

Not applicable

AUTOIGNITION (IGNITION) TEMPERATURE :

Not applicable

EXPLOSION DATA - SENSITIVITY TO MECHANICAL IMPACT :

Stable material. Probably not sensitive.

EXPLOSION DATA - SENSITIVITY TO STATIC CHARGE :

Not applicable

COMBUSTION AND THERMAL DECOMPOSITION PRODUCTS :

Copper oxide

FIRE HAZARD COMMENTS :

Copper in any form does not normally burn.

EXTINGUISHING MEDIA :

Not applicable. Use media suitable to fight fire in surrounding area.

FIRE FIGHTING INSTRUCTIONS :

Not applicable

*** SECTION 6. ACCIDENTAL RELEASE MEASURES ***

PRECAUTIONS :

Dust or powder: Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. Wear adequate personal

protective equipment. Notify government occupational health and safety and environmental authorities.

CLEAN-UP :

Stop or reduce leak if safe to do so. Shovel into clean, dry, labelled containers and cover. Flush area with water. Large spills: Contact fire and emergency services and supplier for advice.

***** SECTION 7. HANDLING AND STORAGE *****

HANDLING :

Use dust-tight containers. Prevent accumulations of dust.
Avoid generating dust.
Label containers. Keep containers closed when not in use. Empty containers may contain residues which are hazardous.

STORAGE :

(Recommendations for copper powder or dust. Some recommendations may also apply to other forms of copper metal).
Store away from incompatible materials.
Store in suitable, labelled containers. Keep containers tightly closed when not in use and when empty. Protect from damage.
Avoid any dust build-up by frequent cleaning and suitable construction of storage area.
Limit quantity of material in storage. Restrict access to storage area.
Post warning signs when appropriate. Keep storage area separate from populated work areas. Inspect periodically for deficiencies such as damage or leaks.

***** SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION *****

NOTE : Exposure to this material can be controlled in many ways. The measures appropriate for a particular worksite depend on how this material is used and on the extent of exposure. This general information can be used to help develop specific control measures. Ensure that control systems are properly designed and maintained. Comply with occupational, environmental, fire, and other applicable regulations.

SAMPLING AND ANALYSIS :

Use appropriate instrumentation and sampling strategy (location, timing, duration, frequency, and number of samples). Interpretation of the sampling results is related to these variables and the analytical method.

NIOSH METHOD(S): 7300 (elements by ICP) - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 1; 7200 (welding and brazing fume) - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 2; 7029 (copper, dust and fume) - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 1

OSHA METHOD(S): IMIS0730 - Copper dust and mist; IMIS0731 - Copper fume

ENGINEERING CONTROLS :

Engineering methods to control hazardous conditions are preferred. Methods include mechanical ventilation (dilution and local exhaust), process or personnel enclosure, control of process conditions, and process modification. Administrative controls and personal protective equipment may also be required. Use local exhaust ventilation, and process enclosure if necessary, to control airborne dust or fume. Locate dust collectors outside or where permitted by regulation. Supply sufficient replacement air to make up for air removed by exhaust system.

PERSONAL PROTECTIVE EQUIPMENT :

If engineering controls and work practices are not effective in controlling

exposure to this material, then wear suitable personal protective equipment including approved respiratory protection. Have appropriate equipment available for use in emergencies such as spills or fire. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection. Refer to the CSA Standard Z94.4-93, "Selection, Care, and Use of Respirators," available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

RESPIRATORY PROTECTION GUIDELINES :

NIOSH RECOMMENDATIONS FOR COPPER DUSTS AND MISTS (as Cu) CONCENTRATIONS IN AIR (17):

UP TO 5 mg/m³: Dust and mist respirator.

UP TO 10 mg/m³: Dust and mist respirator except single-use and quarter-mask respirator (if not present as a fumigant); or SAR; or SCBA.

UP TO 25 mg/m³: Powered air-purifying respirator with dust and mist filter(s); or SAR operated in a continuous-flow mode.

UP TO 50 mg/m³: Full-facepiece respirator with high-efficiency particulate filter(s); or full-facepiece SCBA; or full-facepiece SAR; or powered air-purifying respirator with tight-fitting facepiece and high-efficiency particulate filter.

UP TO 2000 mg/m³: Positive pressure, full-facepiece SAR.

EMERGENCY OR PLANNED ENTRY INTO UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS:

Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

ESCAPE: Full-facepiece respirator with high-efficiency particulate filter(s); or escape-type SCBA.

NOTE: No evidence can be found for the existence of an IDLH.

NOTE: Substance reported to cause eye irritation or damage; may require eye protection.

ABBREVIATIONS: SAR = supplied-air respirator; SCBA = self-contained breathing apparatus. IDLH = Immediately Dangerous to Life or Health.

NOTE: In these recommendations, the IDLH concentration is defined as the maximum concentration which would not cause any escape-impairing symptoms or irreversible health effects to a person exposed for 30 minutes if the respirator failed.

Recommendations apply only to NIOSH and MSHA (Mine Safety and Health Administration) approved respirators.

Air-purifying respirators do not protect against oxygen-deficient atmospheres.

NOTE: NIOSH recommendations also exist for copper fume.(17)

EYE/FACE PROTECTION :

Chemical safety goggles. A face shield may also be necessary.

SKIN PROTECTION :

No specific requirement, but it is good practice to prevent skin contact.

RESISTANCE OF MATERIALS FOR PROTECTIVE CLOTHING :

No specific guidelines are available. Most materials commonly used in protective clothing are probably adequate. Contact the manufacturer/supplier for specific advice.

EXPOSURE CONTROLS/PERSONAL PROTECTION COMMENTS :

Do not eat, smoke or drink in work areas. Wash hands thoroughly after handling this material. Maintain good housekeeping.

** EXPOSURE GUIDELINES **

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF
GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 1993-94 *

TIME-WEIGHTED AVERAGE (TLV-TWA) : 0.2 mg/m³ (fume); 1 mg/m³ (dusts and mists, as Cu)

TLV COMMENTS :

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 0.1 mg/m³ (fume, as Cu); 1 mg/m³ (dusts and mists, as Cu)

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 0.1 mg/m³ (fume - as Cr); 1 mg/m³ (dusts and mists - as Cu)

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 63.546

CONVERSION FACTOR :

Not applicable

MELTING POINT : 1083 deg C (1981 deg F)

BOILING POINT : 2595 deg C (4703 deg F)

RELATIVE DENSITY (SPECIFIC GRAVITY) :

6.94 (water = 1)

SOLUBILITY IN WATER :

Not soluble

SOLUBILITY IN OTHER LIQUIDS :

Not soluble in organic solvents. Readily soluble in nitric acid (reacts); very slowly soluble in hydrochloric or sulphuric acid or ammonium hydroxide solution (reacts).

VAPOUR DENSITY : Not applicable

VAPOUR PRESSURE : Practically zero at room temperature

SATURATION VAPOUR CONCENTRATION : Not applicable

EVAPORATION RATE : Not applicable

PH VALUE : Not applicable

CRITICAL TEMPERATURE : Not applicable

COEFFICIENT OF OIL/WATER DISTRIBUTION (PARTITION COEFFICIENT) :

Not available

*** SECTION 10. STABILITY AND REACTIVITY ***

STABILITY :

Stable material. May turn green on prolonged contact with air due to formation of cupric carbonate.(4)

HAZARDOUS POLYMERIZATION :

Does not occur

HAZARDOUS DECOMPOSITION PRODUCTS :

Not available

INCOMPATIBILITY - MATERIALS TO AVOID :

ACETYLENE - finely divided copper in contact with acetylene forms explosive acetylides.(3) Note that the acetylene present in ethylene oxide is sufficient to form copper acetylide.

STRONG OXIDIZING MATERIALS (eg. chlorates, bromates) - powdered copper mixed with strong oxidants can explode when initiated by heat, shock, and sometimes light friction.(3)

CHLORINE & FLUORINE: Copper will burn in the presence of these gases.(3)

CORROSIVITY TO METALS :

Not corrosive

***** SECTION 11. TOXICOLOGICAL INFORMATION *****

Acute lethality data by oral, dermal or inhalation exposure are not available, but copper metal appears to have low toxicity by these routes. LD50 (intraperitoneal, mouse): 3.5 mg/kg (6); elemental copper appears to be more toxic than its salts by this route.

EYE IRRITATION: Copper particles are not toxic when applied to the surface of the eye. Copper and alloys (brass, bronze) can cause clouding or severe injury when imbedded in the eyes of rabbits, particularly if the particles penetrate near the retina.(8)

TERATOGENICITY/EMBRYOTOXICITY: Oral and intrauterine doses of 152-1520 mg/kg copper resulted in developmental abnormalities and death in the fetus when administered 22 and 35 weeks prior to mating of rats. No maternal toxic effects were observed at these dose levels.(7,15)

These data are of questionable value since intrauterine exposure is often fetotoxic (15), and the Soviet reports of oral administration (7) could not be confirmed.

CARCINOGENICITY: While there is no data for copper metal, salts of copper do not appear to be carcinogenic. Copper may modify the course of tumorigenesis of well established carcinogens (azo dyes such as benzanthrene).(13) These findings are not clear and further research is needed.

***** SECTION 12. ECOLOGICAL INFORMATION *****

NOTE : This section is under development.

***** SECTION 13. DISPOSAL CONSIDERATIONS *****

Review federal, provincial and local government requirements prior to disposal. Store material for disposal as indicated in Storage Conditions. Disposal of dust or powder by secure landfill may be acceptable. Recycling of metal is preferred.

***** SECTION 14. TRANSPORT INFORMATION *****

**** TRANSPORTATION OF DANGEROUS GOODS (TDG) SHIPPING INFORMATION ****

This chemical is not specifically listed in the Canadian Transportation of Dangerous Goods Regulations. However it may be regulated as a part of a chemical family or group Not Otherwise Specified (N.O.S.) (e.g. LIQUID DYES N.O.S.). Consult the regulation.

NOTE: This information incorporates Schedule No. 18 amendments to the Transportation of Dangerous Goods Act, 1992, effective October 1, 1994.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

PROPOSED WHMIS CLASSIFICATION :

Does not meet criteria

WHMIS HEALTH EFFECTS :

Insufficient information

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 1% or greater

DETAILED WHMIS CLASSIFICATION ACCORDING TO CRITERIA :

CLASS A - COMPRESSED GAS: Does not meet criteria

CLASS B - FLAMMABLE & COMBUSTIBLE MATERIAL: Does not meet criteria

CLASS C - OXIDIZING MATERIAL: Does not meet criteria

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 1 - IMMEDIATE AND

SERIOUS TOXIC EFFECTS: Insufficient information for classification

Acute Lethality: Insufficient information

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 2 - OTHER TOXIC

EFFECTS: Insufficient information. See detailed evaluation below.

CHRONIC TOXIC EFFECTS: Insufficient information

CARCINOGENICITY: Does not meet criteria; not in reference lists.

TERATOGENICITY AND EMBRYOTOXICITY: Some reports of teratogenic and embryotoxic effects, but results are inconclusive or questionable.

REPRODUCTIVE TOXICITY: Insufficient information

MUTAGENICITY: Insufficient information

RESPIRATORY TRACT SENSITIZATION: Does not meet criteria; not reported as human respiratory sensitizer.

SKIN IRRITATION: Insufficient data for evaluation. Rare cases of sensitization have been reported.(16)

EYE IRRITATION: Does not meet criteria; application to surface of eye is not irritating; imbedded particles can cause severe eye damage.(8)

SKIN SENSITIZATION: Does not meet criteria

CLASS E - CORROSIVE MATERIAL: Does not meet criteria

CLASS F - DANGEROUSLY REACTIVE MATERIAL: Does not meet criteria

*** SECTION 16. OTHER INFORMATION ***

SELECTED BIBLIOGRAPHY :

(1) The Merck index: an encyclopedia of chemicals, drugs, and biologicals. 10th ed. Merck. 1983. p. 358-359

(2) Hawley's condensed chemical dictionary. 11th ed. Van Nostrand Reinhold, 1987. p. 308

(3) Fire protection guide on hazardous materials. 9th ed. National Fire Protection Association, 1986. p. 491M-68 to 491M-69

(4) HSDB record for copper. Complete update on 06/04/85; printed 1988 12 29

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- (13) Furst, A., et al. A survey of metal carcinogenesis. Progr. exp. Tumor Res. Vol. 12 (1969). p. 102-133
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- (15) Riari, S.S., et al. A new delivery system for metals as contraceptives in animals. Indian Journal of Experimental Biology. Vol. 19 (December 1981). p. 1124-1126
- (16) Saltzer, E.L., et al. Allergic contact dermatitis due to copper. Arch Derm. Vol. 98 (Oct 1968). p. 375-376
- (17) NIOSH pocket guide to chemical hazards. NIOSH, June 1990. p. 72-73, 74-75

Information on chemicals reviewed in the CHEMINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHEMINFO records is available in the database Help.

REVIEW/REPREPARATION DATE :

1989-08-29

REVISION INDICATORS :

PEL-TWA; 1993-03

WHMIS (disclosure list); 1993-03

Trans PEL-TWA; 1993-04

TDG; 1994-03

DOD Hazardous Materials Information System

DoD 6050.5-L

AS OF May 1994

FSC: 1376

NIIN: 00N010938

Manufacturer's CAGE: 2D881

Part No. Indicator: A

Part Number/Trade Name: PROPELLANT,EXPLOSIVE,SOLID,M6+2F/76MM

DINTRO TOWNE

General Information

Item Name:

Manufacturer's Name: HERCULES INCORPORATED

Manufacturer's Street: RADFORD ARMY AMMUNITION PLANT

Manufacturer's P. O. Box:

Manufacturer's City: RADFORD

Manufacturer's State: VA

Manufacturer's Country:

Manufacturer's Zip Code: 24141

Manufacturer's Emerg Ph #: 703-639-7294

Manufacturer's Info Ph #: 703-639-7294

Distributor/Vendor # 1:

Distributor/Vendor # 1 Cage:

Distributor/Vendor # 2:

Distributor/Vendor # 2 Cage:

Distributor/Vendor # 3:

Distributor/Vendor # 3 Cage:

Distributor/Vendor # 4:

Distributor/Vendor # 4 Cage:

Safety Data Action Code:

Safety Focal Point: N

Record No. For Safety Entry: 001

Tot Safety Entries This Stk#: 001

Status:

Date MSDS Prepared: 09JAN86

Safety Data Review Date: 15JUL89

Supply Item Manager:

MSDS Preparer's Name:

Preparer's Company:

Preparer's St Or P. O. Box:

Preparer's City:

Preparer's State:

Preparer's Zip Code:

Other MSDS Number:

MSDS Serial Number: BHVKT

Specification Number:

Spec Type, Grade, Class:

Hazard Characteristic Code:

Unit Of Issue:

Unit Of Issue Container Qty:

Type Of Container:

Net Unit Weight:

NRC/State License Number:

Net Explosive Weight:

Net Propellant Weight-Ammo:

Coast Guard Ammunition Code:

=====

Ingredients/Identity Information

=====

Proprietary: NO
Ingredient: DINITROTOLUENE (SARA III)
Ingredient Sequence Number: 01
Percent: 10.00
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: XT1300000
CAS Number: 25321-14-6
OSHA PEL: S;A2:0.15 MG/M3;9293
ACGIH TLV: S. 1.5 MG/M3
Other Recommended Limit: N/K (FP N/ORNL)

Proprietary: NO
Ingredient: DIBUTYL PHTHALATE (SARA III)
Ingredient Sequence Number: 02
Percent: 3.00
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: TI0875000
CAS Number: 34-74-2
OSHA PEL: 5 MG/M3
ACGIH TLV: 5 MG/M3; 9192
Other Recommended Limit: N/K (FP N/ORNL)

Proprietary: NO
Ingredient: DIPHENYLAMINE
Ingredient Sequence Number: 03
Percent: 1.00
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: JJ7800000
CAS Number: 122-39-4
OSHA PEL: 10 MG/M3
ACGIH TLV: 10 MG/M3; 9192
Other Recommended Limit: N/K (FP N/ORNL)

Proprietary: NO
Ingredient: POTASSIUM SULFATE
Ingredient Sequence Number: 04
Percent: 2.00
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: TT5900000
CAS Number: 7778-80-5
OSHA PEL: N/K (FP N/ORNL)
ACGIH TLV: N/K (FP N/ORNL)
Other Recommended Limit: N/K (FP N/ORNL)

Proprietary: NO
Ingredient: NITROCELLULOSE (FLAMMABLE SOLID)
Ingredient Sequence Number: 05
Percent: 87.00
Ingredient Action Code:
Ingredient Focal Point: N

NIOSH (RTECS) Number: 1004725NF
CAS Number: N/K (FP N)
SHA PEL: N/K (FP N/ORNL)
ACGIH TLV: N/K (FP N/ORNL)
Other Recommended Limit: N/K (FP N/ORNL)

Physical/Chemical Characteristics

Appearance And Odor: HARD CYLINDER, PERFORATED, SMOOTH, GREENISH YELLOW
COLOR. ODORLESS.

Boiling Point: N/A

Melting Point: N/K (FP N)

Vapor Pressure (MM Hg/70 F): NEGLIGIBLE

Vapor Density (Air=1): N/A

Specific Gravity: 1.4955, WATER=1

Decomposition Temperature: N/K (FP N)

Evaporation Rate And Ref: <1 (BUTYL ACETATE=1)

Solubility In Water: NEGLIGIBLE

Percent Volatiles By Volume: N/A

Viscosity:

pH: N/K

Radioactivity:

Form (Radioactive Matl):

Magnetism (Milligauss):

Corrosion Rate (IPY): N/K

Autoignition Temperature:

Fire and Explosion Hazard Data

Flash Point: N/A

Flash Point Method: N/K

Lower Explosive Limit: N/A

Upper Explosive Limit: N/A

Extinguishing Media: SELF-OXIDIZING, DELUGE W/ H₂O. MAY NOT BE ABLE TO
EXTING MATL BEFORE IT IS CONSUMED UNLESS LRG QTY USED IN SHORT TIME.

Special Fire Fighting Proc: USE NIOSH/MSHA APPROVED SCBA AND FULL
PROTECTIVE EQUIPMENT (FP N). EVACUATE THE AREA.

Unusual Fire And Expl Hazrds: EASILY IGNITED, HIGHLY COMBUSTIBLE; PROTECT
FROM FIRE, SPARKS & EXTREME HEAT. AUTOIGNITION TEMP: 383F, 195C. HAZARDOUS
DECOMPOSITION PRODUCTS: OXIDES OF CARBON.

Reactivity Data

Stability: YES

Cond To Avoid (Stability): AVOID OPEN FLAME, SPARKS AND HEAT.

Materials To Avoid: OXIDES OF NITROGEN AND CARBON.

Hazardous Decomp Products: OXIDES OF CARBON.

Hazardous Poly Occur: NO

Conditions To Avoid (Poly): NONE

Health Hazard Data

LD50-LC50 Mixture: N/K (FP N/ORNL)

Route Of Entry - Inhalation: YES

Route Of Entry - Skin: YES

Route Of Entry - Ingestion: YES

Health Haz Acute And Chronic: SEE SIGNS AND SYMPTOMS OF OVEREXPOSURE.

Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO

Explanation Carcinogenicity: NONE

Signs/Symptoms Of Overexp: EYES: N/K (FP N/ORNL). SKIN: TOXIC, AVOID SKIN CONTACT. INGESTION: TOXIC, AVOID INGESTION. INHALATION: TOXIC, AVOID INHALATION.

Med Cond Aggravated By Exp: N/K (FP N/ORNL)

Emergency/First Aid Proc: EYES: IN CASE OF CONTACT, IMMEDIATELY FLUSH WITH PLENTY OF LOW PRESSURE WATER FOR AT LEAST 15 MINUTES. REMOVE ANY CONTACT LENSES TO ASSURE THOROUGH FLUSHING. CALL A PHYSICIAN. SKIN: WASH WITH SOAP AND RUNNING WATER. INGESTION: CONTACT MD IMMEDIATELY (FP N). INHALATION: REMOVE TO FRESH AIR. TREAT ANY IRRITATION SYMPTOMATICALLY. CALL A PHYSICIAN.

=====

Precautions for Safe Handling and Use

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Steps If Mail Released/Spill: CLEAN UP SPILLS IMMEDIATELY USING A SOFT BRISTLE BRUSH AND A CONDUCTIVE RUBBER OR PLASTIC SHOVEL. USE CAUTION, MATERIAL SENSITIVE TO IMPACT, FRICTION AND ELECTROSTATIC DISCHARGE.

Neutralizing Agent: N/K (FP N/ORNL)

Waste Disposal Method: DISPOSAL MUST BE IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N). BURN IN OPEN BURNING GROUND IN ACCORDANCE WITH REGULATIONS. MAY ALSO BE BURNED IN AN INCINERATOR APPROVED FOR EXPLOSIVES.

Precautions-Handling/Storing: AVOID PRING TEMP ABOVE 50C, 125F. REC: 21C, 75F; 50% HUMIDITY. STOR MUST CONFORM TO LOCAL, STATE, FEDERAL REGS (OSHA 19CFR1910.109; DAF 27CFR55 SUBPART K).

Other Precautions: WARNING, FLAMMABLE SOLID. KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAME. KEEP CONTAINERS CLOSED. USE WITH ADEQUATE VENTILATION.

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Control Measures

=====

Respiratory Protection: NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N).

Ventilation: LOCAL AND GENERAL VENTILATION NECESSARY TO KEEP AIR CONCENTRATION BELOW TLV (FP N/ORNL).

Protective Gloves: COTTON OR LEATHER.

Eye Protection: SAFETY GLASSES

Other Protective Equipment: FLAMEPROOF COVERALLS AND CONDUCTIVE SHOES.

Work Hygienic Practices: N/K (FP N/ORNL)

Suppl. Safety & Health Data: ROUTES OF ENTRY: INGEST/SKIN/INHAL (FP N).

* CHEMINFO *
*
* Canadian Centre for Occupational Health and Safety *

*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 2097
CCOHS CHEMICAL NAME : Ferric oxide
SYNONYMS :
* Anhydrous iron oxide
* English red
* Iron (III) oxide
* Iron oxide red
* Oxyde de fer
* Red iron oxide
* Specular iron
* Iron trioxide
CAS REGISTRY NUMBER : 1309-37-1
KECS NUMBER(S) : N07400000
MOLECULAR FORMULA : Fe2O3

STATUS :

This CHEMINFO record is not complete and only contains readily available information at this time.

Information on chemicals reviewed in the CHEMINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHEMINFO records is available in the database help.

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :

Dense, dark red powder or lumps

** EXPOSURE GUIDELINES **

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 1993-94 *

TIME-WEIGHTED AVERAGE (TLV-TWA) : 5 mg/m3, fume (as Fe)-B2

TLV COMMENTS :

B2. WELDING FUMES: The TLV-TWA for total welding fume particulate (not otherwise classified) is 5 mg/m3. Ensure that the TLVs for specific components of the fume are not exceeded.

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 10 mg/m³ (Tune)

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 10 mg/m³

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 159.70
MELTING POINT : 1565 deg C
RELATIVE DENSITY (SPECIFIC GRAVITY) :
5.12 - 5.24 (water=1)
SOLUBILITY IN WATER :
Insoluble
SOLUBILITY IN OTHER LIQUIDS :
Soluble in acids

*** SECTION 12. ECOLOGICAL INFORMATION ***

NOTE : This section is under development.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 1% or greater.

REVIEW/PREPARATION DATE :

1988-07-31

REVISION INDICATORS :

PEL-TWA; 1993-04

Trans PEL-TWA; 1993-04

WHMIS (disclosure list); 1993-04

* C H E M I N F O *
*
* Canadian Centre for Occupational Health and Safety *

*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 550
CCOHS CHEMICAL NAME : Magnesium oxide
SYNONYMS :
* Calcined brucite
* Calcined magnesia
* Calcined magnesite
* Magnesia
* Oxyde de magnésium
* Periclase
TRADE NAME(S) :
Magcal
Maglite
CAS REGISTRY NUMBER : 1309-48-4
RTECS NUMBER(S) : OM3850000
CHEMICAL FAMILY : Magnesium compound
MOLECULAR FORMULA : Mg-O

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :
Fine odourless white powder; hygroscopic (absorbs moisture from the air).
ODOUR THRESHOLD :
Odourless
WARNING PROPERTIES :
None
COMPOSITION/PURITY :
Magnesium oxide is available commercially as caustic-calcined magnesia, dead-burned magnesia and fused magnesia. Impurities can include silica, lime, potassium, aluminum and iron compounds. Occurs in nature as the mineral periclase.
USES AND OCCURRENCES :
Used in making refractory materials (crucibles, furnace linings, fire brick), magnesia cements, boiler-scale compounds, "powdered" oils, petroleum additives, fertilizer. Used as a white colour standard; reflector in optical instruments; food and feed additive; semiconductor; inorganic rubber accelerator. Used in pulp and paper manufacturing.

*** SECTION 3. HAZARDS IDENTIFICATION ***

** POTENTIAL HEALTH EFFECTS **

EFFECTS OF SHORT-TERM (ACUTE) EXPOSURE :
INHALATION :

Magnesium oxide dust is slightly irritating to the nose and causes little adverse effect on the lungs. Evidence from a laboratory study using human volunteers showed that inhalation of freshly formed magnesium oxide fume can cause a mild form of a flu-like illness called metal fume fever.(6) Symptoms of metal fume fever occur 4-12 hours after exposure and can include cough, sweating, headache, fever, muscle aches, nausea, vomiting and tiredness. Recovery is complete. The volunteers were exposed to 4-6 mg/m3 (has been

incorrectly reported as 400-600 mg/m³) for less than 10 minutes and experienced fever and tiredness. However, there have been no reports of metal fume fever caused by industrial exposure to magnesium oxide dust.(5,6)

SKIN CONTACT :

Not absorbed through the skin. Not irritating to the skin, but use of rigorous washing procedures to remove dust may cause skin irritation.

EYE CONTACT :

Dust is slightly irritating to eyes. Some tearing, blinking and mild temporary pain may occur as particles are rinsed from the surface of the eye.

INGESTION :

Practically non-toxic by ingestion.

EFFECTS OF LONG-TERM (CHRONIC) EXPOSURE :

INHALATION: Long industrial experience with this material has shown that it can cause only minor, reversible health effects on the lungs.(1) Long-term exposures to high concentrations of dust may cause increased mucous flow in the nose and respiratory system.(2) This condition usually disappears after exposure ceases.

CARCINOGENICITY :

No human information available. Animal studies by injection produced inconclusive results.

TERATOGENICITY AND EMBRYOTOXICITY :

No specific information available but adverse effects on the unborn child are unlikely.

REPRODUCTIVE TOXICITY :

No specific information available but no reproductive effects are expected.

MUTAGENICITY :

No information available

TOXICOLOGICALLY SYNERGISTIC MATERIALS :

No information available

POTENTIAL FOR ACCUMULATION :

Does not accumulate. Excess magnesium ion is rapidly excreted in the urine.

***** SECTION 4. FIRST AID MEASURES *****

INHALATION :

If symptoms are experienced, remove source of contamination or move victim to fresh air. If symptoms persist or a flu-like illness develops later, obtain medical advice immediately.

SKIN CONTACT :

If irritation occurs, wash gently and thoroughly with water and non-abrasive soap.

EYE CONTACT :

If irritation occurs, flush the contaminated eye(s) with lukewarm, gently flowing water until particles have been removed.

If irritation persists, obtain medical advice immediately.

INGESTION :

No health effects from ingestion expected. Rinse mouth with water and drink some water.

FIRST AID COMMENTS :

All first aid procedures should be periodically reviewed by a physician familiar with the material and its conditions of use in the workplace.

***** SECTION 5. FIRE FIGHTING MEASURES *****

FLASH POINT :

Not combustible (does not burn)

LOWER FLAMMABLE (EXPLOSIVE) LIMIT (LFL/LEL) :

Not applicable
UPPER FLAMMABLE (EXPLOSIVE) LIMIT (UFL/UEL) :
Not applicable
AUTOIGNITION (IGNITION) TEMPERATURE :
Not applicable
EXPLOSION DATA - SENSITIVITY TO MECHANICAL IMPACT :
Not sensitive. Stable material.
EXPLOSION DATA - SENSITIVITY TO STATIC CHARGE :
Not applicable
COMBUSTION AND THERMAL DECOMPOSITION PRODUCTS :
None
EXTINGUISHING MEDIA :
Does not burn. Use media appropriate for surrounding fire.

*** SECTION 6. ACCIDENTAL RELEASE MEASURES ***

RECAUTIONS :

Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. Wear adequate personal protective equipment.

CLEAN-UP :

Use vacuum equipped with HEPA filter(s). Alternatively, dampen spilled material with water and shovel into clean, labelled containers. Cover containers. Flush area with water.

*** SECTION 7. HANDLING AND STORAGE ***

HANDLING :

Use dust-tight labelled containers. Keep containers closed when not in use. Good housekeeping is important to prevent accumulation of dust. The use of compressed air to clean clothing, equipment etc. is not recommended. Avoid generating dust.

STORAGE :

Store away from incompatible materials such as strong acids and interhalogens.
Store in suitable, labelled containers. Keep containers tightly closed when not in use and when empty. Protect from damage.
Avoid any dust build-up by frequent cleaning and suitable construction of storage area.

*** SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION ***

NOTE : Exposure to this material can be controlled in many ways. The measures appropriate for a particular worksite depend on how this material is used and on the extent of exposure. This general information can be used to help develop specific control measures. Ensure that control systems are properly designed and maintained. Comply with occupational, environmental, fire, and other applicable regulations.

SAMPLING AND ANALYSIS :

Use appropriate instrumentation and sampling strategy (location, timing, duration, frequency, and number of samples). Interpretation of the sampling results is related to these variables and the analytical method.

NIOSH METHOD(S): S369 - NIOSH Manual of Analytical Methods. 2nd ed. Vol. 3; 7300 - NIOSH Manual of Analytical Methods. 3rd ed. Vol. 5.

ENGINEERING CONTROLS :

When there is large scale use of this material, (eg. bagging operation) or where dust may be generated, local exhaust ventilation with or without process enclosure may be necessary to control airborne dust. Supply sufficient replacement air to make up for air removed by exhaust system. A dust collecting system attached to the ventilation system may be necessary.

PERSONAL PROTECTIVE EQUIPMENT :

If engineering controls and work practices are not effective in controlling exposure to this material, then wear suitable personal protective equipment including approved respiratory protection. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection. Refer to the CSA Standard Z94.4-93, "Selection, Care, and Use of Respirators," available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

RESPIRATORY PROTECTION GUIDELINES :

No specific guidelines are available.

An approved respirator suitable for protection from dusts may be adequate. Contact the manufacturer/supplier for specific advice.

The respirator use limitations specified by the approving agency and the manufacturer must be observed.

EYE/FACE PROTECTION :

No specific requirement, but it is good practice to wear chemical safety goggles.

SKIN PROTECTION :

No specific requirement, but it is good practice to prevent skin contact. Wear coveralls or long sleeves and pants to prevent accumulation of dust on skin.

RESISTANCE OF MATERIALS FOR PROTECTIVE CLOTHING :

Most materials commonly used in protective clothing are probably adequate.

**** EXPOSURE GUIDELINES ****

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF
GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 1993-94 *

TIME-WEIGHTED AVERAGE (TLV-TWA) : 10 mg/m³, (Magnesium oxide fume)

TLV COMMENTS :

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 10 mg/m³ total particulate (magnesium oxide fume)

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision.. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 15 mg/m³ (total particulate)

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 40.32
CONVERSION FACTOR :
Not applicable
MELTING POINT : 2800 deg C (5072 deg F)
BOILING POINT : 3600 deg C (6512 deg F)
RELATIVE DENSITY (SPECIFIC GRAVITY) :
3.58 (water = 1)
SOLUBILITY IN WATER :
Very slightly soluble (forms magnesium hydroxide)
SOLUBILITY IN OTHER LIQUIDS :
Soluble in acids and ammonium salt solutions. Insoluble in alcohol.
VAPOUR DENSITY : Not applicable
VAPOUR PRESSURE : Essentially zero
SATURATION VAPOUR CONCENTRATION : Not applicable
EVAPORATION RATE : Not applicable
pH VALUE : 10.3 (saturated aqueous solution)
CRITICAL TEMPERATURE : Not applicable
COEFFICIENT OF OIL/WATER DISTRIBUTION (PARTITION COEFFICIENT) :
Not applicable

*** SECTION 10. STABILITY AND REACTIVITY ***

STABILITY :
Stable
HAZARDOUS POLYMERIZATION :
Does not occur
HAZARDOUS DECOMPOSITION PRODUCTS :
None
INCOMPATIBILITY - MATERIALS TO AVOID :
INTERHALOGENS (eg. BROMINE PENTAFLUORIDE) - fire sometimes results from contact.
STRONG ACIDS - can react vigorously.
CORROSIVITY TO METALS :
Not corrosive

*** SECTION 11. TOXICOLOGICAL INFORMATION ***

No standard acute toxicity values are available.
CARCINOGENICITY (hamster): Intratracheal injections produced a significant increase in the incidence of tumours in lymph nodes, liver and spleen but not in the respiratory system. Injections of magnesium oxide and diethylnitrosamine, a known cancer-causing agent, did not produce a significant increase in tumours.(7)
The significance of this study is not clear. The route of exposure (intratracheal injection) makes the study of questionable relevance to workplace exposure.

*** SECTION 12. ECOLOGICAL INFORMATION ***

NOTE : This section is under development.

*** SECTION 13. DISPOSAL CONSIDERATIONS ***

Review federal, provincial and local government requirements prior to disposal. Disposal by secure landfill may be acceptable.

*** SECTION 14. TRANSPORT INFORMATION ***

** TRANSPORTATION OF DANGEROUS GOODS (TDG) SHIPPING INFORMATION **

This chemical is not specifically listed in the Canadian Transportation of Dangerous Goods Regulations. However it may be regulated as a part of a chemical family or group Not Otherwise Specified (N.O.S.) (e.g. LIQUID DYES N.O.S.). Consult the regulation.

NOTE: This information incorporates Schedule No. 18 amendments to the Transportation of Dangerous Goods Act, 1992, effective October 1, 1994.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

PROPOSED WHMIS CLASSIFICATION :

Does not meet criteria

WHMIS HEALTH EFFECTS :

Does not meet criteria

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 1% or greater

DETAILED WHMIS CLASSIFICATION ACCORDING TO CRITERIA :

CLASS A - COMPRESSED GAS: Does not meet criteria

CLASS B - FLAMMABLE & COMBUSTIBLE MATERIAL: Does not meet criteria

CLASS C - OXIDIZING MATERIAL: Does not meet criteria

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 1 - IMMEDIATE AND SERIOUS TOXIC EFFECTS: Probably does not meet criteria. Toxicity information is incomplete but related materials do not meet criteria.

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 2 - OTHER TOXIC EFFECTS: Probably does not meet criteria. Toxicity information is incomplete but related materials do not meet criteria.

CLASS E - CORROSIVE MATERIAL: Does not meet criteria

CLASS F - DANGEROUSLY REACTIVE MATERIAL: Does not meet criteria

*** SECTION 16. OTHER INFORMATION ***

SELECTED BIBLIOGRAPHY :

- (1) Documentation of the threshold limit values and biological exposure indices. 5th ed. ACGIH, 1986. p. 351
- (2) Patty's industrial hygiene and toxicology. 3rd rev. ed. Vol. 1. John Wiley & Sons, 1978. p. 183-185
- (5) Patty's industrial hygiene and toxicology. 3rd rev. ed. Vol. 2A. John Wiley & Sons, 1981. p. 1740-1749
- (6) Drinker, P., et al. Metal fume fever: III. the effects of inhaling magnesium oxide fume. Journal of Industrial Hygiene. Vol. 9, no. 5 (1927). p. 187-192
- (7) Stenback, F.G., et al. Synergistic effects of diethylnitrosamine and different dusts on respiratory carcinogenesis in hamsters. Cancer Research. Vol. 33 (Oct. 1973). p. 2209-2214

Information on chemicals reviewed in the CHEMINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHEMINFO records is available in the database Help.

EVIDENCE PREPARATION DATE :

1703-05-29

REVISION INDICATORS :

PEL-TWA; 1993-03

WHMIS (disclosure list); 1993-03

Trans PEL-TWA; 1993-04

120; 1994-03

 * CHEMINFO *
 *
 * Canadian Centre for Occupational Health and Safety *

*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 9
 CCOSHS CHEMICAL NAME : Potassium hydroxide
 SYNONYMS :
 * Caustic potash
 * Potassium hydrate
 * Lye
 * Potassa
 * KOH
 * Hydroxyde de potassium
 CAS REGISTRY NUMBER : 1310-58-3
 OTHER CAS REGISTRY NUMBER(S) : 29857-72-5 71769-53-4
 PIN (UN/NA NUMBER(S)) : 1813 1814
 RTECS NUMBER(S) : TT2100000
 CHEMICAL FAMILY : Alkali hydroxide
 MOLECULAR FORMULA : H-K-O
 STRUCTURAL FORMULA : KOH

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :
 White odourless solid. Available as pellets, flakes, lumps or sticks.
 Commonly available in solution. Hygroscopic (absorbs moisture from the air).
 ODOUR THRESHOLD :
 Odourless
 WARNING PROPERTIES :
 Poor - no odour
 COMPOSITION/PURITY :
 Available commercially at 88-92% purity. Contains not more than 3.5% potassium carbonate. Remainder is predominantly water. Very high purity grades (99%+) are commercially available.
 USES AND OCCURRENCES :
 Manufacture of soaps, printing inks, paint and varnish removers, dyestuffs, liquid fertilizers and herbicides; electroplating, photoengraving and lithography; electrolyte in alkaline storage batteries and some fuel cells; mordant for wood; absorbent for carbon dioxide and hydrogen sulfide; organic synthesis; food additive.

*** SECTION 3. HAZARDS IDENTIFICATION ***

** POTENTIAL HEALTH EFFECTS **

EFFECTS OF SHORT-TERM (ACUTE) EXPOSURE :
 INHALATION :
 Irritation of the nose, throat and lungs could occur due to the corrosive nature of potassium hydroxide. However, severe injury is usually avoided by self-limiting sneezing, coughing and discomfort.
 SKIN CONTACT :
 Extremely corrosive. Capable of causing severe burns with deep ulceration. Can penetrate to deeper layers of skin causing permanent scarring and

possibly death. Corrosion can continue until removed. Severity of injury depends on the concentration and duration of exposure. Burns are not immediately painful; onset of pain may be minutes to hours.

EYE CONTACT :

Extremely corrosive. Can penetrate deeply, causing irritation or severe burns depending on the concentration and duration of exposure. In severe cases, ulceration and permanent blindness may occur.

INGESTION :

There are no reported cases of industrial workers ingesting potassium hydroxide or its solutions. Should ingestion occur, severe pain; burning of the mouth, throat and esophagus; vomiting; diarrhea; collapse and possible death may result.

EFFECTS OF LONG-TERM (CHRONIC) EXPOSURE :

There have been no documented effects due to long-term exposure to potassium hydroxide. Repeated skin contact may result in drying, cracking and inflammation.

CARCINOGENICITY :

Potassium and sodium hydroxide have been implicated as a cause of cancer of the esophagus in individuals who have ingested it. The cancer may develop 1 to 42 years after the ingestion incident. Similar cancers have been observed at the sites of severe thermal burns. These cancers may be due to tissue destruction and scar formation rather than the action of the hydroxide itself.

TERATOGENICITY AND EMBRYOTOXICITY :

Information not available

REPRODUCTIVE TOXICITY :

Information not available

MUTAGENICITY :

Insufficient information

TOXICOLOGICALLY SYNERGISTIC MATERIALS :

Information not available

POTENTIAL FOR ACCUMULATION :

Does not accumulate

***** SECTION 4. FIRST AID MEASURES *****

INHALATION :

Remove source of contamination or move victim to fresh air. Obtain medical advice immediately.

SKIN CONTACT :

Avoid direct contact with this chemical. Wear impervious protective gloves, if necessary. As quickly as possible, flush contaminated area with lukewarm, gently running water for at least 30 minutes, by the clock. Under running water, remove contaminated clothing, shoes, and leather goods (e.g. watchbands, belts). If irritation persists, repeat flushing. Obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before re-use or discard.

EYE CONTACT :

Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 30 minutes, by the clock, holding the eyelid(s) open. Take care not to rinse contaminated water into the non-affected eye. If available, a neutral saline solution may be used to flush the contaminated eye(s) an additional 30 minutes. If irritation persists, repeat flushing. Obtain medical attention immediately.

INGESTION :

Never give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Rinse mouth thoroughly with water. **DO NOT INDUCE VOMITING.** If victim can swallow, have him/her drink 8 to 10 ozs.

(240 to 300 ml) of water to dilute material in stomach. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water. Obtain medical attention immediately.

FIRST AID COMMENTS :

Provide general supportive measures (warmth, comfort and rest). Consult a physician and/or the nearest poison control centre for all cases of ingestion or eye contact and all but trivial cases of inhalation or skin contact.

***** SECTION 5. FIRE FIGHTING MEASURES *****

FLASH POINT :

Non-combustible (does not burn)

LOWER FLAMMABLE (EXPLOSIVE) LIMIT (LFL/LEL) :

Not applicable

UPPER FLAMMABLE (EXPLOSIVE) LIMIT (UFL/UEL) :

Not applicable

AUTOIGNITION (IGNITION) TEMPERATURE :

Not applicable

EXPLOSION DATA - SENSITIVITY TO MECHANICAL IMPACT :

Not sensitive

EXPLOSION DATA - SENSITIVITY TO STATIC CHARGE :

Not applicable

COMBUSTION AND THERMAL DECOMPOSITION PRODUCTS :

None

FIRE HAZARD COMMENTS :

Potassium hydroxide and its solutions will not burn or support combustion. However, reaction of potassium hydroxide with a number of commonly encountered materials (see Chemical Reactivity) can generate sufficient heat to ignite nearby combustible materials. Reaction of potassium hydroxide with certain metals can generate flammable and explosive hydrogen gas.

EXTINGUISHING MEDIA :

Use an extinguisher appropriate to the material which is burning

FIRE FIGHTING INSTRUCTIONS :

Water can be used to extinguish a fire in an area where potassium hydroxide is stored as long as the water does not come into contact with the potassium hydroxide.

**** NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD INDEX ****

NFPA - HEALTH	: 3 - Short exposure could cause serious temporary or residual injury.
NFPA - FLAMMABILITY	: 0 - Will not burn
NFPA - REACTIVITY	: 1 - Normally stable but can become unstable at elevated temperatures and pressures, or may react non-violently with water.

***** SECTION 6. ACCIDENTAL RELEASE MEASURES *****

PRECAUTIONS :

Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. Wear adequate protective clothing and equipment. Ventilate area of spill. Remove combustible materials from the vicinity of a major spill. Notify government occupational health and safety and environmental authorities.

CLEAN-UP :

Contain spill or leak. Do not allow entry into sewers or waterways. Shovel or sweep up dry potassium hydroxide for recycling or disposal. Neutralize

final traces and flush area with water. Spilled solutions should be contained by diking with inert materials, such as sand or earth. Solutions can be recovered or carefully diluted with water and cautiously neutralized with acids such as acetic or hydrochloric acid.

*** SECTION 7. HANDLING AND STORAGE ***

HANDLING :

Avoid generating mist or dust. Keep solid KOH away from water. Post "DO NOT USE WATER" signs in area of use. When diluting or preparing solution, add caustic to water in small amounts to avoid boiling and splattering. Label containers and keep closed when not in use. Empty containers may contain residues which are hazardous.

STORAGE :

Store in water-tight containers in a cool, dry place separate from the normal work area. Materials that react violently with potassium hydroxide and easily ignitable materials should not be stored in the same area. Use corrosion-resistant structural materials, lighting and ventilation systems in the storage area. Store in suitable, labelled containers. Keep containers closed when not in use and when empty. Protect from damage. Limit quantity of material in storage. Restrict access to storage area. Post warning signs when appropriate. Keep storage area separate from populated work areas. Inspect periodically for deficiencies such as damage or leaks.

*** SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION ***

NOTE : Exposure to this material can be controlled in many ways. The measures appropriate for a particular workplace depend on how this material is used and on the extent of exposure. This general information can be used to help develop specific control measures. Ensure that control systems are properly designed and maintained. Comply with occupational, environmental, fire, and other applicable regulations.

SAMPLING AND ANALYSIS :

Published methods for sampling/analysis of potassium hydroxide are not available.

ENGINEERING CONTROLS :

Engineering methods to control hazardous conditions are preferred. General methods include mechanical ventilation (dilution and local exhaust), process or personnel enclosure, control of process conditions and process modification (e.g., substitution of a less hazardous material). Administrative controls and personal protective equipment may also be required. Use a corrosion-resistant ventilation system separate from other exhaust ventilation systems. Exhaust directly to the outside. Use local exhaust ventilation, and process enclosure if necessary, to control airborne dust / mist. Supply sufficient replacement air to make up for air removed by exhaust systems.

PERSONAL PROTECTIVE EQUIPMENT :

If engineering controls and work practices are not effective in controlling exposure to this material, then wear suitable personal protective equipment including approved respiratory protection. Have appropriate equipment available for use in emergencies such as spills or fire. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection.

Refer to the CSA Standard Z94.4-93, "Selection, Care, and Use of Respirators," available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

RESPIRATORY PROTECTION GUIDELINES :

No specific guidelines are available. Contact chemical manufacturer/supplier for specific advice.

The NIOSH recommendations for SODIUM HYDROXIDE may be applicable.(2) See CHEMINFO record 5E for details.

EYE/FACE PROTECTION :

Dust or splash proof chemical safety goggles or face shields (eight-inch minimum).

SKIN PROTECTION :

Impervious gloves, coveralls, aprons, overshoes, and/or other resistant protective clothing.

RESISTANCE OF MATERIALS FOR PROTECTIVE CLOTHING :

Potassium Hydroxide: GOOD: Butyl rubber, natural rubber, neoprene, nitrile/polyvinyl chloride (PVC), nitrile, PVC, neoprene/styrene-butadiene rubber (SBR), SBR, SBR/neoprene. FAIR/POOR: Viton, polyurethane. Potassium Hydroxide, 30-70%: VERY GOOD: Natural rubber, neoprene, nitrile/PVC, nitrile, PVC. GOOD: Butyl rubber, chlorinated polyethylene, Viton/neoprene, polyethylene, butyl rubber/neoprene, neoprene/natural rubber, SBR. FAIR/POOR: Polyvinyl alcohol NOTE: Resistance of specific materials can vary from product to product. Evaluate resistance under conditions of use and maintain clothing carefully.

EXPOSURE CONTROLS/PERSONAL PROTECTION COMMENTS :

NOTE: Eye wash fountains and safety showers should be located near any area where potassium hydroxide is handled. Remove contaminated clothing promptly. Keep contaminated clothing in closed containers. Discard or launder before re-wearing. Inform laundry personnel of contaminant's hazards. Do not smoke, eat or drink in work areas. Wash hands thoroughly after handling this material. Maintain good housekeeping.

** EXPOSURE GUIDELINES **

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF
GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 1993-94 *

CEILING EXPOSURE LIMIT (TLV-C) : 2 mg/m3

TLV COMMENTS :

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted and implemented can vary, obtain detailed information from the appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

CEILING EXPOSURE LIMIT (PEL-C) : 2 mg/m3

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : Not established

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 56.10

CONVERSION FACTOR :

Not applicable

MELTING POINT : Approx. 360 deg C (680 deg F)

BOILING POINT : Approx. 1320 deg C (2408 deg F) @ 760 mm Hg

RELATIVE DENSITY (SPECIFIC GRAVITY) :

2.044 @ 20 deg C (water=1)

SOLUBILITY IN WATER :

Very soluble (107 g/100 ml @ 15 deg C; 178 g/100 ml @ 100 deg C)

SOLUBILITY IN OTHER LIQUIDS :

Soluble in alcohol and glycerol; insoluble in ether and ammonia.

VAPOUR DENSITY : Not applicable

VAPOUR PRESSURE : Practically zero

SATURATION VAPOUR CONCENTRATION : Not applicable

EVAPORATION RATE : Not applicable

pH VALUE : Approx. 13 (1% solution)

CRITICAL TEMPERATURE : Not applicable

COEFFICIENT OF OIL/WATER DISTRIBUTION (PARTITION COEFFICIENT) :

Log P(oct) = 0.65; 0.83

*** SECTION 10. STABILITY AND REACTIVITY ***

STABILITY :

Stable

HAZARDOUS POLYMERIZATION :

Does not occur

HAZARDOUS DECOMPOSITION PRODUCTS :

None

INCOMPATIBILITY - MATERIALS TO AVOID :

ACIDS - violent reaction can occur, yielding heat and pressure which can burst an enclosed container.

WATER - reaction may generate enough heat to ignite combustible materials.

METALS - reaction may produce flammable and explosive hydrogen gas.

ORGANOHALOGEN COMPOUNDS - may react to form spontaneously combustible

compounds. MALEIC ANHYDRIDE AND NITRO AND CHLORO ORGANIC COMPOUNDS - may react explosively.

CORROSIVITY TO METALS :

Corrosive to aluminum, tin, zinc. Corrosive to steel at elevated temperatures.

STABILITY AND REACTIVITY COMMENTS :

Potassium hydroxide readily absorbs carbon dioxide from the air.

*** SECTION 11. TOXICOLOGICAL INFORMATION ***

LD50 (oral, rat): 365 mg/kg (6)

LD50 (oral, male rat): 273 mg/kg (5)

EYE IRRITATION (Rabbit): Application of 0.1 mL of 5.0% potassium hydroxide solution for 5 minutes, before washing the eye with distilled water for 2 minutes, resulted in extreme irritation and corrosion. Application of 0.1 mL of a 1% solution for 5 minutes, or 24 hours before washing the eye resulted in irritation. A 0.1% solution applied for 24 hours before washing the eye caused no irritation.(6)

SKIN IRRITATION: A 10% solution was corrosive to rabbits and guinea pigs

when applied to intact or broken skin for 4 hours.(7)

Application of 0.1 mL of a 5% solution to intact or broken skin of rabbits for 24 hours resulted in mild irritation to intact skin and extreme irritation of broken skin.(6)

SKIN SENSITIZATION (Guinea Pigs): 0.1 mL of a 0.1% solution was injected under the skin of male guinea pigs 3 times weekly for a total of 9 treatments. Following 2 weeks where no injections were made, a challenge dose of 0.1 mL was administered and the animals were observed at 24, 48 and 72 hours. Potassium hydroxide did not cause skin sensitization in this study.(6)

*** SECTION 12. ECOLOGICAL INFORMATION ***

NOTE : This section is under development.

*** SECTION 13. DISPOSAL CONSIDERATIONS ***

Federal, provincial and local regulations should be reviewed prior to disposal. May be possible to neutralize, dilute and flush the material into a sewer. Harmful to aquatic life in high concentrations.

*** SECTION 14. TRANSPORT INFORMATION ***

** TRANSPORTATION OF DANGEROUS GOODS (TDG) SHIPPING INFORMATION **

SHIPPING NAME AND DESCRIPTION: Potassium hydroxide, solid or flake

PRODUCT IDENTIFICATION NUMBER (PIN): 1813

CLASSIFICATION: 8 - Corrosive substance; 9.2 - Substance hazardous to the environment

SPECIAL PROVISIONS: 109

PACKING GROUP: II

REGULATED LIMIT: ---

SHIPPING NAME AND DESCRIPTION: Potassium hydroxide, solution

PRODUCT IDENTIFICATION NUMBER (PIN): 1814

CLASSIFICATION: 8 - Corrosive substance; 9.2 - Substance hazardous to the environment

SPECIAL PROVISIONS: 109

PACKING GROUP: II or III

REGULATED LIMIT: ---

NOTE: This information incorporates Schedule No. 18 amendments to the Transportation of Dangerous Goods Act, 1992, effective October 1, 1994.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

PROPOSED WHMIS CLASSIFICATION :

D1B - Poisonous and infectious material - Immediate and serious effects - Toxic

E - Corrosive material

WHMIS HEALTH EFFECTS :

Acute lethality - toxic - immediate

Corrosive to skin

TDG class 8 - corrosive substance

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 1% or greater

DETAILED WHMIS CLASSIFICATION ACCORDING TO CRITERIA :

CLASS A - COMPRESSED GAS: Does not meet criteria

CLASS B - FLAMMABLE & COMBUSTIBLE MATERIAL: Does not meet criteria

CLASS C - OXIDIZING MATERIAL: Does not meet criteria

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 1 - IMMEDIATE AND SERIOUS TOXIC EFFECTS: Meets criteria for "Toxic material."

Acute Lethality: "Toxic"; LD50 (oral, rat) 345 mg/kg

CLASS D - POISONOUS AND INFECTIOUS MATERIAL. DIVISION 2 - OTHER TOXIC EFFECTS: Does not meet criteria; see detailed evaluation below.

CHRONIC HEALTH EFFECTS: Insufficient information

CARCINOGENICITY: Insufficient information

TERATOGENICITY AND EMBRYOTOXICITY: Insufficient information

REPRODUCTIVE TOXICITY: Insufficient information

MUTAGENICITY: Insufficient information

RESPIRATORY TRACT SENSITIZATION: Does not meet criteria; not reported as human respiratory sensitizer.

SKIN IRRITATION: Does not meet criteria. Corrosive materials are not also classified as irritants.

EYE IRRITATION: Does not meet criteria. Corrosive materials are not also classified as irritants.

SKIN SENSITIZATION: Does not meet criteria

CLASS E - CORROSIVE MATERIAL: Meets criteria; corrosive to steel - aluminum - animal skin; TDG Class 8

CLASS F - DANGEROUSLY REACTIVE MATERIAL: Does not meet criteria

CSHA HAZARD COMMUNICATION EVALUATION :

Meets criteria for hazardous material, as defined by 29 CFR 1910.1200.

*** SECTION 16. OTHER INFORMATION ***

SELECTED BIBLIOGRAPHY :

- (1) Sodium hydroxide. Printout from CHEMINFO data base, September, 1989
- (2) NIOSH pocket guide to chemical hazards. NIOSH, June 1990. p. 198-199
- (3) Documentation of the threshold limit values and biological exposure indices. 5th ed. ACGIH, 1986. p. 495
- (4) Patty's industrial hygiene and toxicology. 3rd rev. ed. Vol. 2B. John Wiley & Sons, 1981. p. 3055-3056
- (5) Bruce, R.D. A confirmatory study of the up-and-down method for acute oral toxicity testing. Fundamental and Applied Toxicology. Vol. 8 (1987). p. 97-100
- (6) Johnson, G.L., et al. Acute toxicity of cesium and rubidium compounds. Toxicology and Applied Pharmacology. Vol. 32 (1975). p. 239-245
- (7) Nixon, G.A., et al. Interspecies comparisons of skin irritancy. Toxicology and Applied Pharmacology. Vol. 31 (1975). p. 481-490

Information on chemicals reviewed in the CHEMINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHEMINFO records is available in the database Help.

REVIEW/PREPARATION DATE :

1990-11-21

REVISION INDICATORS :

PEL-C; 1993-03

NFPA (health); 1993-03

NEPA (reactivity): 1993-03

REGULATORY INFORMATION: 1994-03

Trans FEL-TM4: 1993-04

TDS: 1994-02

Material Safety Data Sheet

Genium Publishing Corporation
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No. 181

SILVER

Issued: April 1986

SECTION 1. MATERIAL IDENTIFICATION

20

MATERIAL NAME: SILVER

DESCRIPTION: Elemental metal.

OTHER DESIGNATIONS: Ag, Argentum, CAS #7440-22-4.

MANUFACTURER/SUPPLIER: Available from many suppliers.

COMMENTS: Photography products account for 30% of industrial consumption. Additional uses include electrical conductors, coins, silverware, and jewelry.

HMIS

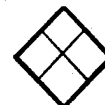
H:1

F:0

R:0

PPE*

*See sect. 8



Not Found

SECTION 2. INGREDIENTS AND HAZARDS

% HAZARD DATA

Silver, Ag

99+

TWA 0.1 mg/m³*

TWA 0.01 mg/m³**

* Current (1985-86) ACGIH TLV for silver dust and fume.

** Current (1985-86) ACGIH TLV for soluble silver compounds and OSHA exposure limit.

Rat, Implant, TD: 2570 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point ... 3833.6°F (2112°C)

Vapor Pressure ... Not Found

Water Solubility ... Insoluble

Vapor Density (Air = 1) ... Not Found

Evaporation Rate ... Not Found

Specific Gravity (H₂O = 1) ... 10.5

Melting Point ... 1763.4°F (961.9°C)

Percent Volatile by Volume ... Not Found

Molecular Weight ... 107.87

Appearance and odor: Ductile and malleable lustrous white metal.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER UPPER

Flash Point and Method

Autoignition Temp.

Flammability Limits In Air

Not Found

Not Found

Not Found

Not

Applicable

Not

Applicable

NFPA Classification: Noncombustible.

EXTINGUISHING MEDIA: Use proper extinguisher for surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None.

SPECIAL FIRE-FIGHTING PROCEDURES: None.

SECTION 5. REACTIVITY DATA

Silver is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES: Acetylene and silver form an insoluble, explosive acetylide. If silver is treated with nitric acid in the presence of ethyl alcohol, silver fulminate may be formed, which can be detonated.

Ethylenimine forms explosive compounds with silver. Finely divided silver and hydrogen peroxide solutions may explode. This material is incompatible with oxalic and tartaric acid. Ammonia plus silver may form explosive compounds. Bromoazide explodes on contact with silver foil.

SECTION 6: HEALTH HAZARD INFORMATION | TLV

Silver is not considered a carcinogen by the NTP, IARC, or OSHA.

SUMMARY OF RISKS: Silver has no known physiological function in man and will accumulate in most tissues. Chronic accumulation (threshold in excess of 1 gram) in the body can result in argyria, a permanent condition associated with widespread bluish pigmentation of the skin and conjunctiva. **TARGET ORGANS:** Generally, where contact occurs. **PRIMARY ENTRY:** Inhalation, long-term handling (causes particles to become embedded in skin), or absorption through sweat glands. **ACUTE EFFECTS** are associated with soluble silver compounds that may be caustic, causing local irritations or destruction of tissue, depending upon strength of solution. **CHRONIC EFFECTS:** Argyria may be a local or general effect, depending upon previous exposure. **FIRST AID:** **EYE CONTACT:** Flush with water for 15 minutes. Get medical attention.* **SKIN CONTACT:** Wash skin with soap and water. Argyria from long-term exposure is permanent and cannot be washed away. **INHALATION:** Remove victim to fresh air. **INGESTION:** Dilute with water. Get medical attention.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

COMMENTS: The original 0.01 mg/m³ TLV was established to prevent a lifetime body accumulation exceeding 1 gram, where argyria would become evident. Evaluation of 25 years of data has shown 0.01 mg/m³ to be too conservative; therefore, the ACGIH raised the TLV to 0.1 mg/m³.

SECTION 7: SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel; prevent entry into sewers or surface waters. Wear respirator where a dusting hazard is anticipated.

WASTE DISPOSAL: Reclaim or sell waste to a commercial reclaimer.

SECTION 8: SPECIAL PROTECTION INFORMATION

GOGGLES are not required unless metal is in the molten state.

GLOVES: Repeated handling may discolor the skin because of skin rubbing against the metal. Cotton gloves will prevent this cosmetic effect.

RESPIRATOR is required where metal dust or fumes are generated with inadequate exhaust ventilation. Air samples should be collected to quantify the exposure levels.

VENTILATION is required where air exposures exceed the TLV-TWA'S.

OTHER: Reclamation of silver from photographic or X-ray film may involve cyanide compounds. Proper precautions must be taken when working with cyanide compounds. See Genium MSDS #13, Potassium Cyanide, for further information.

SECTION 9: SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Silver is usually stored in locked cabinets or safes to prevent theft.

ENGINEERING CONTROLS: Exhaust ventilation where TLV-TWA is exceeded.

EPA Hazardous Substance Designation: 40 CFR 260

Data Source(s) Code: 2, 4, 6, 14, 59, 82, 84, NFC 1983. DW

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Approvals *JO. DeMarco*

Indust. Hygiene/Safety *JW*

Medical Review *[Signature]*



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Material Safety Data Sheets Collection:

Sheet No. 263
Sodium Bicarbonate

Issued: 8/89

Section 1. Material Identification

Sodium Bicarbonate Description: Prepared from sodium carbonate, water, and carbon dioxide (CO_2). Used to manufacture many sodium salts; as a source of carbon dioxide; in fire extinguishers and cleaning compounds; and as an ingredient of baking powder and effervescent salts/beverages.

Other Designations: Baking soda; sodium acid carbonate; sodium hydrogen carbonate; monosodium carbonate; bicarbonate of soda; NaHCO_3 ; CAS No. 144-55-8.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 0
I -
S 3
K 0



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* Sc

Section 2. Ingredients and Occupational Exposure Limits

Sodium bicarbonate, ca 100%

OSHA PEL
None established

ACGIH TLV, 1988-89
None established

NIOSH REL
None established

Toxicity Data*
Infant, oral, TD_{10} : 1260 mg/kg
Infant, oral, LD_{50} : 4220 mg/kg

*See NIOSH, RTECS (VZ0950000), for additional data with references to reproductive and irritative effects.

Section 3. Physical Data

Water Solubility: Complete
pH: *

Molecular Weight: 84 g/mol

Appearance and Odor: White crystalline powder or granules; odorless.

* The aqueous solutions of sodium bicarbonate prepared with cold water and no agitation are only slightly alkaline to litmus or phenolphthalein. The alkalinity increases as the temperature rises and as time passes. A freshly prepared 0.1-molar solution of sodium bicarbonate at 77 °F (25 °C) has a pH of 8.3.

Section 4. Fire and Explosion Data

Flash Point: *	Autoignition Temperature: *	LEL: *	UEL: *
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Extinguishing Media: * Sodium bicarbonate does not burn. Use extinguishing agents that put out the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand positive-pressure mode to protect against the effects of the surrounding fire.

Section 5. Reactivity Data

Stability/Polymerization: Sodium bicarbonate is stable at room temperature during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Sodium bicarbonate can react dangerously with monoammonium phosphate or a sodium-potassium alloy.

Conditions to Avoid: Sodium bicarbonate decomposes by reaction with acids.

Hazardous Products of Decomposition: Sodium bicarbonate starts to give off carbon dioxide gas at 122 °F (50 °C). At 212 °F (100 °C) the sodium bicarbonate converts to sodium carbonate (Na_2CO_3).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists sodium bicarbonate as a carcinogen.

Summary of Risks: Sodium bicarbonate is an alkaline powder that can irritate the tissues it contacts. Dryness, scaling, and alkaline burns of exposed tissue can occur, depending on the exposure's intensity and duration. The alkaline irritant effects of sodium bicarbonate solutions increase as the solution's concentration and strength increase. Sodium bicarbonate's toxicity is low and the FDA has approved its use as a general-purpose food additive.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Skin, eyes, and mucous membranes lining the respiratory system.

Primary Entry: Inhalation, skin contact.

Acute Effects: Irritation, with possible alkaline chemical burns, of the skin, eyes, and the mucous membranes of the respiratory tract. Moist skin probably increases the alkaline irritant effects.

Chronic Effects: None reported.

FIRST AID

Eyes: Immediately flush, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min. Alkaline/basic eye burns are possible. Treatment by competent medical personnel is necessary to prevent permanent eye damage.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air, and support breathing as needed.

Ingestion: If ingested, have the exposed person drink 1 to 2 glasses of water. If the quantities or concentrations are excessive, induce vomiting by giving an emetic such as Syrup of Ipecac.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety and cleanup personnel of a sodium bicarbonate spill. Cleanup personnel should wear personal protective equipment (Sec. 8) to prevent excessive skin contact or dust inhalation. Do not create dusty conditions during cleanup operations. Shovel, scoop, or vacuum the spilled material into appropriate disposal containers. Never flush to sewers, surface waters, waterways, or watersheds.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Where splashing is possible, wear a full face shield.

Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations that protect worker safety productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store sodium bicarbonate in closed containers in a cool, dry, well-ventilated area away from acids. Protect these containers from physical damage.

Transportation Data (49 CFR 172.101-2): Not listed

MSDS Collection References: 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122

Prepared by: PJ Igoc, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

F1



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 48
Sodium Carbonate, Anhydrous

Issued: 12/84

Revision: B, 11/91

Section 1. Material Identification

Sodium Carbonate, anhydrous (Na_2CO_3) Description: Exists in nature as brines, saltwater in lakes, and solid stratified deposits. Produced commercially by reaction between sodium chloride and ammonia, sodium chloride and sulfuric acid, or by leaching out rock salt deposits. Used in manufacturing glass, caustic soda, sodium bicarbonate, pulp and paper, aluminum, detergents, salts and paints; in desulphurization of pig iron and purification of petroleum.

Other Designations: CAS No. 497-19-8, crystal carbonate, disodium carbonate, sal soda, soda ash, Trona, washing soda.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷⁾ for a suppliers list.

R 1
I -
S 2
K 0



HM
H
F
R
PPG
* See

Cautions: Sodium carbonate is corrosive, can be mildly toxic by inhalation and ingestion and, is an eye and skin irritant.

Section 2. Ingredients and Occupational Exposure Limits

Sodium carbonate, anhydrous, ca 98%*

1990 OSHA PEL†
None established

1990 DFG (Germany) MAK
None established

1985-86 Toxicity Data‡

Rat, oral, LD_{50} : 4090 mg/kg; toxic effects not yet reviewed

Rat, inhalation, LC_{50} : 2300 mg/m³/2 hr caused difficulty in breathing

Rabbit, eye: 100 mg/24 hr produced moderate irritation

1991-92 ACGIH TLV
None established

1990 NIOSH REL
None established

* The product contains 98% sodium carbonate, 1% sodium chloride, 0.1% sodium sulfate, and traces of cyanogen, arsenic, and sulfur salts.

† Control at least as a nuisance particulate; current OSHA PEL values are 15 mg/m³ (total dust) and 5 mg/m³ (respirable dust).

‡ See NIOSH, RTECS (VZ4050000), for additional irritation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: Decomposes at 752 °F (400 °C)

Density: 2.53 at 77 °F (25 °C)

Melting Point: 1567 °F (853 °C)

Water Solubility: Soluble in 3.5 parts water at room temperature

pH: Aqueous solution is 11.6

Other Solubilities: Soluble in glycerol, insoluble in most organic solvents

Molecular Weight: 106

Appearance and Odor: White, odorless, hygroscopic (readily moisture-absorbing) powder with an alkaline taste.

Section 4. Fire and Explosion Data

Flash Point: Noncombustible

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Sodium carbonate, anhydrous, is a noncombustible material. Use extinguishing media suitable for surrounding fire. For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

Unusual Fire or Explosion Hazards: None reported.

Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also wear fully protective clothing. Use water spray to reduce dust. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sodium carbonate, anhydrous, is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. It readily absorbs moisture from the air to form sodium bicarbonate and various hydrates. 400 °C this material begins to decompose, releasing CO_2 and sodium oxide (Na_2O).

Chemical Incompatibilities: Sodium carbonate may become explosive in contact with red-hot aluminum metal, and is incompatible with ammonia + silver nitrate, 2,4-dinitrotoluene, 2,4,6-trinitrotoluene, sulfuric acid, sodium sulfide + water, lithium, phosphorus pentoxide, fluorine and hydrogen peroxide. Hot concentrated solutions of sodium carbonate are mildly corrosive to steel.

Conditions to Avoid: Avoid excessive dust generation and contact with heat, moisture and the incompatibles listed above.

Hazardous Products of Decomposition: Thermal oxidative decomposition of sodium carbonate, anhydrous, can produce carbon dioxide (CO_2) and toxic sodium oxide (Na_2O) fumes.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list sodium carbonate, anhydrous, as a carcinogen.

Summary of Risks: As typical with alkaline corrosives, sodium carbonate toxicity relates more to concentration than to dose. It can be mildly toxic by inhalation, ingestion, and skin or eye contact. Prolonged or repeated contact with concentrated solutions causes tissue damage. "Soda ulcers" on the hands and perforation of the nasal septum have occurred.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Eyes, skin, respiratory and digestive systems.

Primary Entry Routes: Inhalation, ingestion, skin or eye contact.

Acute Effects: Acute inhalation can produce eyes, nose, and throat irritation, sneezing, difficulty in breathing, coughing, and possible chemical bronchitis (inflammation of bronchial tubes in the lungs due to inhalation of a chemical). Ingestion may cause irritation in the mouth, chest and stomach, painful swallowing, and stomach cramps. Moist skin contact has produced an itching, burning, and tingling sensation, redness, and swelling. Sodium carbonate introduced into the eyes may cause mechanical and chemical irritation, pain, watering of eyes, corneal burns, conjunctivitis, and risk of serious injury if eyes are kept tightly closed. **Warning!** Other symptoms may appear from absorption of sodium carbonate into the bloodstream via the eyes.

Chronic Effects: None reported.

FIRST AID

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* let victim rub or keep eyes tightly shut. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with water, *but do not* use soap!

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute poison. *Do not attempt to neutralize as this could cause further damage. Do not* induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Consider endoscopy in all suspected cases of sodium carbonate poisoning. Perform blood analysis to determine if dehydration, acidosis, or other electrolyte imbalances occurred.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate hazard area, deny entry, and stay upwind of spills. For small dry spills, avoid excess dust generation by carefully scooping or vacuuming (with appropriate filter) material and placing it in a suitable container for later disposal. For large, dry land spills, dike around spill to contain and cover with a plastic sheet or other impermeable membrane layer to prevent leaching caused by rain or other water source. Neutralize spills by adding dilute hydrochloric acid. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and the presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** *Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰⁰⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing.

Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in cool, dry, well-ventilated area away from heat, strong acids, and incompatibles (Sec. 5). Keep containers tightly closed to prevent moisture absorption.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Other Precautions: If respirators are used, OSHA requires a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid excess dust generation. Also consider preplacement and periodic medical examinations of exposed workers emphasizing the skin, eyes, and respiratory tract.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 73, 100, 101, 103, 124, 126, 127, 132, 136, 139, 140, 149, 159, 163

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

* M S D S *
*
* Canadian Centre for Occupational Health and Safety *

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 756024
PRODUCT NAME(S) : SODIUM NITRATE
PRODUCT IDENTIFICATION : 06SDNA
DATE OF MSDS : 1994-06-09

*** MANUFACTURER INFORMATION ***

MANUFACTURER : GRACE DEARBORN INC
ADDRESS : 3451 ERINDALE STATION ROAD
MISSISSAUGA ONTARIO
CANADA L5C 2S9
EMERGENCY TELEPHONE NO. : 905-279-2222 (OFFICE HOURS)
613-996-6666 (AFTER HOURS)

*** MATERIAL SAFETY DATA ***

Page 1 Version #: 3.00
MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

1) PRODUCT IDENTIFICATION: SODIUM NITRATE

PRODUCT USE: COMMODITY CHEMICAL

MANUFACTURER:	EMERGENCY PHONE:
GRACE DEARBORN INC.	
3451 ERINDALE STATION ROAD	OFFICE HOURS: 905-279-2222
MISSISSAUGA, ONTARIO	
L5C 2S9	AFTER HOURS: 613-996-6666

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:

SODIUM NITRATE 5.1 UN1498 III

WHMIS CLASSIFICATION:

CLASS C; CLASS D DIVISION 2 SUBDIVISION B

2) INGREDIENTS:

Chemical Name.	CAS #	TLV(mg/m3)	LD50(mg/Kg)
SODIUM NITRATE	7631-99-4	N/E	2000C
	RANGE-(60.0- 100.0)		

3) PHYSICAL DATA:

Physical state.....	SOLID	Freezing point.(Deg.C)	N/A
Odour threshold.....	N/D	Boiling point..(Deg.C)	N/A
Specific gravity.....	1.28	Vapour pressure.....	N/A
Density.....	N/D	Vapour density(air=1).	N/A
pH.....	1% = 7 - 8	Evaporation rate.....	N/A
Solubility in water..	73	Coeff. of water/oil...	N/D
Appearance and odour..			

WHITE PELLETS, ODOURLESS

=====

1) FIRE AND EXPLOSION HAZARD DATA:

CONDITIONS OF FLAMMABILITY:

NON-FLAMMABLE

EXTINGUISHING MEDIA:

WATER X

FOAM X

CO2 X

Other : DRY CHEMICAL

SPECIAL PROCEDURES:

TREAT AS A CLASS A FIRE.

MODERATE WHEN MIXED WITH ORGANIC MATTER - EXPLODES WHEN
HEATED OVER 1000 DEGREES C - OXIDIZING AGENTS.

FLASH POINT: (Deg. C PMCC) NONE

FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D UPPER N/D

AUTO IGNITION TEMP: (Deg. C) N/D

HAZARDOUS COMBUSTION PRODUCTS: N/D

EXPLOSION DATA:

SENSITIVITY TO IMPACT..... :NONE KNOWN

SENSITIVITY TO STATIC DISCHARGES...:NONE KNOWN

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Version #: 3.00

MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

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2) REACTIVITY DATA:

STABILITY (NORMAL COND.) STABLE X UNSTABLE

CONDITIONS TO AVOID:

AVOID EXTREME HEAT ABOVE 1000 DEGREES C

CONDITIONS OF REACTIVITY:

N/D

INCOMPATIBILITY: (MATERIALS TO AVOID)

ORGANIC MATERIALS

HAZARDOUS DECOMPOSITION PRODUCTS:

N/D

=====

3) TOXICOLOGICAL PROPERTIES:

ROUTE OF ENTRY: SKIN CONTACT X ABSORBED BY SKIN EYE CONTACT X

INHALATION X INGESTION X

EFFECTS OF ACUTE EXPOSURE

MAY CAUSE IRRITATION TO SKIN AND EYES. AVOID PROLONGED AND/
OR REPEATED CONTACT.

MAY CAUSE DISCOMFORT, NAUSEA OR VOMITING IF INGESTED.

MAY CAUSE IRRITATION TO UPPER RESPIRATORY TRACT IF INHALED.

EFFECTS OF CHRONIC EXPOSURE:

N/D

Oral rat LD50mg/Kg.(calc.):>2000

Exposure limits..... :N/D

Irritancy..... :N/D

Sensitization.....:N/D

Synergistic Mat..... :NONE KNOWN

Carcinogenicity..... :NONE KNOWN

Reproductive Eff..... :NONE KNOWN

Teratogenicity..... :NONE KNOWN

Mutagenicity..... :NONE KNOWN

=====

7) PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT:

EYE PROTECTION:X

GLOVES:X

CLOTHING:X

RESPIRATORY PROTECTION:

DUST MASK

VENTILATION REQUIREMENTS:

MECHANICAL (GENERAL)

SPILL AND LEAK PROCEDURES:

PICK UP DRY SPILLS AND RETURN TO CONTAINER. FLUSH
REMAINDER TO DRAIN WITH EXCESS WATER.

WASTE DISPOSAL:

USE AN APPROVED SCAVENGER SERVICE.

HANDLING PROCEDURES:

WEAR CHEMICAL GOGGLES AND RUBBER GLOVES.

USE PERSONAL PROTECTIVE CLOTHING.

STORAGE REQUIREMENTS:

STORE AWAY FROM ORGANICS IN DRY FIREPROOF BINS.

WOOD AND PAPER BAGS SATURATED WITH SODIUM NITRATE SHOULD
BE REMOVED FROM PREMISES.

SPECIAL HANDLING INFORMATION:

NONE

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Version #:

3.00

MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

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8) FIRST AID MEASURES:

WASH CONTAMINATED AREA THOROUGHLY WITH SOAP AND WATER. LAUNDER CLOTHING
BEFORE REUSE. FLUSH EYES WITH FLOWING WATER FOR 15 MINUTES AND GET MEDICAL
ATTENTION. IF INGESTED, INDUCE VOMITING AND GIVE LARGE QUANTITIES OF
WATER AND GET MEDICAL ATTENTION IMMEDIATELY.
GASTRIC LAVAGE MAY BE REQUIRED.

=====

9) OTHER INFORMATION:

NONE

=====

10) PREPARATION INFORMATION

PREPARED BY: T.R.Erwin.

GRACE DEARBORN INC.

P.O. BOX 3060 STATION A.

MISSISSAUGA ONTARIO. L5A 3T5

N/D-No Data N/A-Not Applicable N/E-Not Established <-Less >-Greater

A=Oral rat LD50 B=Oral rat LD low C=oral LD50/LD low other animal

D=Estimated 1000 E=Arbitrary 2000 F=Other Route Prefix C=Ceiling limit

..

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H S D S

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MSDS RECORD NUMBER      : 691068
PRODUCT NAME(S)         : Sodium Nitrite Solution
PRODUCT IDENTIFICATION   : MSDS NUMBER: CECOC191
DATE OF MSDS             : 1993-10-28
```

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-367-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

DuPont
Material Safety Data Sheet

Page 1

DEC00191 Sodium Nitrite Solution
Revised 28-OCT-1993 Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

Corporate MSDS Number : DU002807
Formula : NaNO_2 (in water)
CAS Name : NITROUS ACID, SODIUM SALT
Grade : TECHNICAL; OXIDIZING SALT SOLUTION

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont Canada, Inc.
P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
TECHNICAL GRADE:		
SODIUM NITRITE	7632-00-0	41
WATER	7732-18-5	59
OXIDIZING SALT SOLUTION:		
SODIUM NITRITE	7632-00-0	40
SODIUM CARBONATE	497-19-8	2
SODIUM NITRATE	7631-99-4	10

OSL: REPORTED/INCLUDED

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful or fatal if swallowed. Harmful if inhaled.
Overexposure by inhalation or ingestion may cause reduced oxygen carrying capacity of blood. Causes skin and eye irritation.

HUMAN HEALTH EFFECTS:

CEC00191

DuPont

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Material Safety Data Sheet

(HAZARDS IDENTIFICATION - Continued)

Human health effects of overexposure to the product by skin or eye contact may include skin irritation with discomfort or rash; or eye irritation with discomfort, tearing, or blurring of vision. Sodium nitrite has been infrequently associated with skin sensitization in humans. By inhalation, irritation of the upper respiratory passages with coughing may occur. By inhalation or ingestion, the effects may include low blood pressure with headache and fainting, or nonspecific discomfort such as nausea or weakness. Overexposure may also cause methemoglobinemia (reduced oxygen carrying capacity of the blood) with cyanosis (bluish discoloration of the skin), possibly progressing to dizziness, incoordination, shortness of breath, increased pulse rate, and loss of consciousness.

Sodium nitrite can also react with certain amines forming compounds which may cause cancer, mutations, or other toxicity. These compounds, known as nitrosamines, can be formed in acidic environments such as that found in the stomach. Since many medications and chemicals contain an amine group, simultaneous exposure to nitrites should be avoided.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing. Call a physician. Wash clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, immediately give two glasses of water and induce vomiting. Call a physician. Never give anything by mouth to an unconscious person.

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Material Safety Data Sheet

(FIRST AID MEASURES - Continued)

Notes to Physicians

Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need to be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Autodecomposition : 490 C (914 F) after drydown

Will not burn.

Fire and Explosion Hazards:

Strong oxidizer when water is removed. Combustible materials may catch fire more easily after being wet with sodium nitrite and dried. Product intensifies combustion of other materials. Fires are difficult to extinguish. See "Decomposition".

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Flood with water.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

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DuPont

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Material Safety Data Sheet

(ACCIDENTAL RELEASE MEASURES - Continued)

Accidental Release Measures

Flush spill area with plenty of water. Comply with Federal, State, and local regulations on reporting releases. The Superfund reportable discharge for sodium nitrite is 100 lbs.

HANDLING AND STORAGE

Handling (Personnel)

Do not take internally. Keep from contact with clothing and other combustible materials. Avoid contact with eyes and skin. Avoid breathing vapors or mist. Avoid breathing dust from dried-down product. Wash thoroughly after handling.

Storage

Do not store with acids, ammonium salts, cyanides, amines or reducing agents.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Good general ventilation should be provided to minimize contact with vapors, or dust from dried-down product.

Personal Protective Equipment

Eye/Face : Coverall chemical splash goggles.
Protective Gloves : Rubber gloves.

If product is allowed to dry and dusty conditions exist, use NIOSH/MSHA approved respiratory protection.

Exposure Guidelines

Applicable Exposure Limits

SODIUM NITRITE
PEL (OSHA) : None Established

TLV (ACGIH)	: None Established
AEL * (Du Pont)	: 2 mg/m ³ , 8 Hr. TWA, respirable dust
WEEL (AIHA)	: None Established

SODIUM NITRITE
CEC00191

DuPont
Material Safety Data Sheet

Page 5

(Continued)

REL (OSHA)	: None Established
TLV (ACGIH)	: None Established
AEL * (Du Pont)	: 2 mg/m ³ , 8 Hr. TWA, respirable dust
WEEL (AIHA)	: None Established

SODIUM CARBONATE

REL (OSHA)	: None Established
TLV (ACGIH)	: None Established
AEL * (Du Pont)	: 5 mg/m ³ , 8 Hr. TWA

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water	: 100 WT% Technical and Oxidizing Salt Solution
Odor	: Odorless
Form	: Clear liquid

	Technical	Oxidizing Salt!
		Solution
Color	Pale Yellow	Straw Colored
Boiling Pt., 760 mmHg!	115 deg C (239 deg F)	114.5 deg C (238 deg F)
Freezing Point	-1 deg C (30 deg F)	~10-20 deg C (50-68 deg F)
Specific Gravity	1.32 at 16 deg C (60 deg F)	~1.4/16 deg C (34/60 deg F)
Vapor Pressure at		
25 deg C	17 mmHg	~50 mmHg
38 deg C	35 mmHg	~90 mmHg
Vapor Density (Air=1)	Less than 1	Less than 1
pH Information	8.9	9
Evaporation Rate	Greater than 1	Greater than 1!

STABILITY AND REACTIVITY

Chemical Stability

Unstable with heat after dry down.

Decomposition

Decomposes with heat.

Decomposition temperature is 490 deg C (914 deg F) after drydown to produce oxygen and toxic nitrogen gases..

Polymerization

Polymerization will not occur.

Other Hazards

Incompatibility : Incompatible with acids, ammonium salts, amines, activated carbon, cyanides, and reducing agents. May react with secondary or tertiary amines to form nitrosamines (Certain nitrosamines are cancer-suspect agents.).

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

96-hour LC50, minnows: >100 mg/L

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, flush to waste treatment system.

TRANSPORTATION INFORMATION

Shipping Information

DOT
Proper Shipping Name : Hazardous Substance, Liquid, N.O.S.*
Hazard Class : ORM-E
I.D. No. (UN/NA) : NA No: 9188
DOT Label(s) : None
Special Information : *Not regulated in packages containing
less than 300 lbs.
DOT Placard : None

DOT/IMO
Proper Shipping Name : Not regulated as a hazardous material.
Hazard Class : Not regulated.

Reportable Quantity : 100 lb

Shipping Containers

T/C, T/I, sample bottles

Shipping Information -- Canada

TDG
Proper Shipping Name : OXIDIZING SUBSTANCES N.O.S. LIQUID
(SODIUM NITRITE, SODIUM NITRATE, SODIUM
CARBONATE)
PIN No. : UN 1479
TDG Class : 5.1, (9.2)
TDG Packing Group : II

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS C Oxidizing Material

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye
Irritant.

CEC00191

DuPont
Material Safety Data Sheet

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OTHER INFORMATION

Additional Information

...

Title III Classifications:

Acute Health - Yes
Chronic Health - Yes
Fire Hazard - No
Reactivity - No
Pressure - No

For further information, see Du Pont's "Sodium Nitrite" Data Sheet.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : CHEMICALS & PIGMENTS
Address : MISSISSAUGA, ONTARIO
Telephone : 416-821-3300

* Indicates updated section.

End of MSDS

C C S

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

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MSDS RECORD NUMBER      : 730985
PRODUCT NAME(S)         : SODIUM SULFATE
PRODUCT IDENTIFICATION   : J.T. BAKER MSDS NUMBER: 85018
                        CAS NO.: 7757-82-6
                        PRODUCT CODES: 3867,3902,5059,3375,3891,3898
DATE OF MSDS            : 1994-03-09

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*** MANUFACTURER INFORMATION ***

MANUFACTURER
ADDRESS

: J. T. BAKER INC
: 222 RED SCHOOL LANE
PHILLIPSBURG NEW JERSEY
U.S.A. 08865
EMERGENCY TELEPHONE NO.: 908-859-2151 (24-HOURS)
800-424-9300 (CHEMTREC)
800-424-8802 (NATIONAL RESPONSE CENTER)

*** MATERIAL SAFETY DATA ***

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (908) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

85018 M05
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SODIUM SULFATE

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ISSUED: 04/02/94

J.T.BAKER INC., 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: SODIUM SULFATE
COMMON SYNONYMS: SULFURIC ACID, DISODIUM SALT; DISODIUM SULFATE
CHEMICAL FAMILY: INORGANIC SODIUM COMPOUNDS
FORMULA: Na2SO4
FORMULA WT.: 142.04
CAS NO.: 7757-82-6
HOSH/RTECS NO.: WE1650000
PRODUCT USE: LABORATORY REAGENT
PRODUCT CODES: 3887,3902,5059,3375,3691,3896

PRECAUTIONARY LABELING

BAKER SAF-T-DATA* SYSTEM

HEALTH	-	0	NONE
FLAMMABILITY	-	0	NONE
REACTIVITY	-	0	NONE
CONTACT	-	1	SLIGHT

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES; LAB COAT

U.S. PRECAUTIONARY LABELING

CAUTION
MAY CAUSE IRRITATION. MAY BE HARMFUL IF SWALLOWED OR INHALED. HYGROSCOPIC.
DURING USE AVOID CONTACT WITH EYES, SKIN, CLOTHING. WASH THOROUGHLY AFTER
HANDLING. WHEN NOT IN USE KEEP IN TIGHTLY CLOSED CONTAINER.

INTERNATIONAL LABELING

AVOID CONTACT WITH EYES. AFTER CONTACT WITH SKIN, WASH IMMEDIATELY WITH
PLENTY OF WATER. KEEP CONTAINER TIGHTLY CLOSED.

SAF-T-DATA* STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

CONTINUED ON PAGE: 2

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
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SECTION II - COMPONENTS

COMPONENT	CAS NO.	WEIGHT %	OSHA/PEL	ACGIH/TLV
SODIUM SULFATE	7757-82-6	90-100	N/E	N/E

SECTION III - PHYSICAL DATA

BOILING POINT: N/A	VAPOR PRESSURE (MMHG): N/A
MELTING POINT: 884 C (1623 F) (AT 760 MM HG)	VAPOR DENSITY (AIR=1): N/A
SPECIFIC GRAVITY: 2.68 (H2O=1)	EVAPORATION RATE: N/A
SOLUBILITY(H2O): APPRECIABLE (>10%)	% VOLATILES BY VOLUME: 0 (21 C)
PH: N/A	
ODOR THRESHOLD (P.P.M.): N/A	PHYSICAL STATE: SOLID
COEFFICIENT WATER/OIL DISTRIBUTION: N/A	
APPEARANCE & ODOR: WHITE CRYSTALS OR POWDER. ODORLESS.	

=====

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

=====

FLASH POINT (CLOSED CUP): N/A

AUTOIGNITION TEMPERATURE: N/A

FLAMMABLE LIMITS: UPPER - N/A LOWER - N/A

FIRE EXTINGUISHING MEDIA

USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.

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J.T. BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

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SECTION IV - FIRE AND EXPLOSION HAZARD DATA (CONTINUED)

=====

UNUSUAL FIRE & EXPLOSION HAZARDS

NONE IDENTIFIED.

TOXIC GASES PRODUCED

SULFUR DIOXIDE

EXPLOSION DATA-SENSITIVITY TO MECHANICAL IMPACT

NONE IDENTIFIED.

EXPLOSION DATA-SENSITIVITY TO STATIC DISCHARGE

NONE IDENTIFIED.

=====

SECTION V - HEALTH HAZARD DATA

=====

THRESHOLD LIMIT VALUE (TLV/TWA): NOT ESTABLISHED

SHORT-TERM EXPOSURE LIMIT (STEL): NOT ESTABLISHED

PERMISSIBLE EXPOSURE LIMIT (PEL): NOT ESTABLISHED

TOXICITY OF COMPONENTS

ORAL MOUSE LD50 FOR SODIUM SULFATE

5989 MG/KG

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

CARCINOGENICITY

NONE IDENTIFIED.

REPRODUCTIVE EFFECTS

NONE IDENTIFIED.

EFFECTS OF OVEREXPOSURE

INHALATION: IRRITATION OF UPPER RESPIRATORY TRACT

SKIN CONTACT: IRRITATION

EYE CONTACT: IRRITATION

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J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

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SECTION V.- HEALTH HAZARD DATA (CONTINUED)

=====

SKIN ABSORPTION: NONE IDENTIFIED

INGESTION: GASTROINTESTINAL IRRITATION

CHRONIC EFFECTS: NONE IDENTIFIED

TARGET ORGANS

RESPIRATORY SYSTEM, LUNGS

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

.....
NONE IDENTIFIED

PRIMARY ROUTES OF ENTRY

.....
INHALATION, INGESTION, SKIN CONTACT, EYE CONTACT

EMERGENCY AND FIRST AID PROCEDURES

.....
INGESTION: IF SWALLOWED AND THE PERSON IS CONSCIOUS, IMMEDIATELY GIVE
LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

INHALATION: IF A PERSON BREATHES IN LARGE AMOUNTS, MOVE THE EXPOSED
PERSON TO FRESH AIR.

SKIN CONTACT: IN CASE OF CONTACT, IMMEDIATELY WASH SKIN WITH PLENTY OF
SOAP AND WATER FOR AT LEAST 15 MINUTES.

EYE CONTACT: IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH WITH PLENTY OF
WATER FOR AT LEAST 15 MINUTES.

SARA/TITLE III HAZARD CATEGORIES AND LISTS

.....
ACUTE: YES CHRONIC: YES FLAMMABILITY: NO PRESSURE: NO REACTIVITY: NO

EXTREMELY HAZARDOUS SUBSTANCE: NO

PERCLA HAZARDOUS SUBSTANCE: NO

SARA 313 TOXIC CHEMICALS: YES CONTAINS SODIUM SULFATE

GENERIC CLASS: GENERIC CLASS REMOVED FROM CFR: 7/1/91

TSCA INVENTORY: YES

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SECTION VI - REACTIVITY DATA

=====

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: MOISTURE

INCOMPATIBLES: STRONG OXIDIZING AGENTS

DECOMPOSITION PRODUCTS: OXIDES OF SULFUR

=====

SECTION VII - SPILL & DISPOSAL PROCEDURES

=====

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SUITABLE PROTECTIVE CLOTHING. CAREFULLY SWEEP UP AND REMOVE.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

=====

SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT

=====

VENTILATION: USE ADEQUATE GENERAL OR LOCAL EXHAUST VENTILATION TO KEEP FUME OR DUST LEVELS AS LOW AS POSSIBLE.

RESPIRATORY PROTECTION: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION IS HIGH, USE AN APPROPRIATE RESPIRATOR OR DUST MASK.

EYE/SKIN PROTECTION: SAFETY GOGGLES, RUBBER GLOVES ARE RECOMMENDED.

=====

SECTION IX - STORAGE AND HANDLING PRECAUTIONS

=====

SAF-T-DATA* STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

STORAGE REQUIREMENTS

KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA. KEEP FROM CONTACT WITH OXIDIZING MATERIALS. ISOLATE FROM INCOMPATIBLE MATERIALS.

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J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
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SECTION IX - STORAGE AND HANDLING PRECAUTIONS (CONTINUED)

=====

SPECIAL PRECAUTIONS

MATERIAL IS HYGROSCOPIC.

SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME: CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME: CHEMICALS, N.O.S. (NON-REGULATED)
MARINE POLLUTANTS: NO

AIR (I.C.A.O.)

PROPER SHIPPING NAME: CHEMICALS, N.O.S. (NON-REGULATED)

U.S. CUSTOMS HARMONIZATION NUMBER: 28332900006

NOTE: WHEN HANDLING LIQUID PRODUCTS, SECONDARY PROTECTIVE CONTAINERS MUST BE USED FOR CARRYING.

N/A = NOT APPLICABLE, OR NOT AVAILABLE;

N/E = NOT ESTABLISHED.-

THE INFORMATION IN THIS MATERIAL SAFETY DATA SHEET MEETS THE REQUIREMENTS OF THE UNITED STATES OCCUPATIONAL SAFETY AND HEALTH ACT AND REGULATIONS PROMULGATED THEREUNDER (29 CFR 1910.1200 ET. SEQ.) AND THE CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM. THIS DOCUMENT IS INTENDED ONLY AS A GUIDE TO THE APPROPRIATE PRECAUTIONARY HANDLING OF THE MATERIAL BY A PERSON TRAINED IN, OR SUPERVISED BY A PERSON TRAINED IN, CHEMICAL HANDLING. THE USER IS RESPONSIBLE FOR DETERMINING THE PRECAUTIONS AND DANGERS OF THIS CHEMICAL FOR HIS OR HER PARTICULAR APPLICATION. DEPENDING ON USAGE, PROTECTIVE CLOTHING INCLUDING EYE AND FACE GUARDS AND RESPIRATORS MUST BE USED TO AVOID CONTACT WITH MATERIAL OR BREATHING CHEMICAL VAPORS/FUMES.

EXPOSURE TO THIS PRODUCT MAY HAVE SERIOUS ADVERSE HEALTH EFFECTS. THIS CHEMICAL MAY INTERACT WITH OTHER SUBSTANCES. SINCE THE POTENTIAL USES ARE SO VARIED, BAKER CANNOT WARN OF ALL OF THE POTENTIAL DANGERS OF USE OR INTERACTION WITH OTHER CHEMICALS OR MATERIALS. BAKER WARRANTS THAT

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J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

MATERIAL SAFETY DATA SHEET

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CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8602

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THE CHEMICAL MEETS THE SPECIFICATIONS SET FORTH ON THE LABEL.
BAKER DISCLAIMS ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED WITH REGARD
TO THE PRODUCT SUPPLIED HEREUNDER, ITS MERCHANTABILITY OR ITS FITNESS
FOR A PARTICULAR PURPOSE.

THE USER SHOULD RECOGNIZE THAT THIS PRODUCT CAN CAUSE SEVERE INJURY AND
EVEN DEATH, ESPECIALLY IF IMPROPERLY HANDLED OR THE KNOWN DANGERS OF USE
ARE NOT HEEDED. READ ALL PRECAUTIONARY INFORMATION. AS NEW DOCUMENTED
GENERAL SAFETY INFORMATION BECOMES AVAILABLE, BAKER WILL PERIODICALLY
REVISE THIS MATERIAL SAFETY DATA SHEET.

NOTE: CHEMTREC, CARUTEC, AND NATIONAL RESPONSE CENTER EMERGENCY TELEPHONE
NUMBERS ARE TO BE USED ONLY IN THE EVENT OF CHEMICAL EMERGENCIES INVOLVING
A SPILL, LEAK, FIRE, EXPOSURE, OR ACCIDENT INVOLVING CHEMICALS. ALL
NON-EMERGENCY QUESTIONS SHOULD BE DIRECTED TO CUSTOMER SERVICE
(1-800-373-BAKER) FOR ASSISTANCE.

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APPROVED BY QUALITY ASSURANCE DEPARTMENT.

--- LAST PAGE ---



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 294
Sodium Sulfide

Issued: 4/90

Section 1. Material Identification

Sodium Sulfide Description: Best prepared from the elements in liquid ammonia. Also obtained by dehydrating sodium sulfide nonahydrate. Used in manufacturing rubber and sulfur dyes; in metal refining, cotton printing, dehairing hides, wool pulling, engraving, ore flotation, paper-pulping process, and desulfurizing viscose rayon; as a photographic reagent, a chemical intermediate, and a laboratory reagent.

Other Designations: CAS No. 1313-82-2; Na₂S; sodium monosulfide; sodium sulfuret; sodium sulphide.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R 3
I -
S 3
K -



HMIS
H 2
F 2
R 2
PPG*
* Sec.

Section 2. Ingredients and Occupational Exposure Limits

Sodium sulfide, ca 100%

OSHA PEL

None established

ACGIH TLV, 1989-90

None established

NIOSH REL, 1987

None established

Toxicity Data*

None listed

*Monitor NIOSH, RTECS (WE1905000), for future toxicity data.

Section 3. Physical Data

Melting Point: 2156 °F/1180 °C

Molecular Weight: 78.04 g/mol

Specific Gravity (H₂O = 1 at 39 °F/4 °C): 1.856 at 57 °F/14 °C

Water Solubility: Soluble

Appearance and Odor: Yellow-pink or white, deliquescent crystals.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Use dry chemical, CO₂, Halon, water spray, or standard foam to fight fires involving sodium sulfide.

Unusual Fire or Explosion Hazards: Sodium sulfide is a moderately flammable solid when exposed to heat or flame. It can explode with rapid heating or percussion. When it contacts acids, this material yields flammable hydrogen sulfide. When burned, it yields sulfur dioxide. Finely divided sodium sulfide forms explosive mixtures in air.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterway.

Section 5. Reactivity Data

Stability/Polymerization: Although stable at room temperature in closed containers under normal storage and handling conditions, sodium sulfide is unstable and can explode with rapid heating or percussion. This material is extremely hygroscopic (absorbs moisture from the air) and discolors upon exposure to the air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: This material reacts violently with water, carbon, diazonium salts, o-nitroaniline diazonium salt, n,n-dichloromethylamine, acids, and oxidizing materials.

Conditions to Avoid: Avoid contact with heat or any ignition source.

Hazardous Products of Decomposition: Thermal oxidative decomposition of sodium sulfide can produce toxic fumes of sulfur oxides (SO₂) and sodium oxide (Na₂O).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists sodium sulfide as a carcinogen.

Summary of Risks: Sodium sulfide is a strong irritant to skin and tissue. It yields toxic sulfur dioxide when burning and toxic hydrogen sulfide on contact with acids. High concentrations (500 to 1000 ppm) of hydrogen sulfide (*MSDS Collection*, No. 52) can cause systemic poisoning symptomized by respiratory paralysis and unconsciousness, followed by death. Sulfur dioxide (*MSDS Collection*, No. 50) affects the respiratory tract, causing bronchial irritation, difficulty in breathing, pulmonary edema, and at high levels, possible respiratory paralysis. Short-term exposures above 400 to 500 ppm are immediately life threatening.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Skin, eyes, respiratory tract.

Primary Entry Routes: Inhalation, skin or tissue contact.

Acute Effects: Direct contact with sodium sulfide irritates the skin and other tissue. Eye contact may cause painful conjunctivitis, colored halo effects on vision, and lid spasm.

Chronic Effects: None reported.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: Eye exposure may result in fundoscopic and retinal changes that usually resolve within 72 hr. All eye exposures should have baseline and follow-up fundoscopic evaluation. If exposure is significant, nitrate-induced methemoglobinemia has been advocated as treatment on the basis that methemoglobin bind the toxic hydrosulfide anion, forming sulfmethemoglobin. Inhaling amyl nitrate or intravenous sodium nitrite is recommended. Do not use thiosulfate.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and immediately remove all heat and ignition sources. Cleanup crew should protect against vapor inhalation and direct skin or eye contact. Do not handle with bare hands! Using nonsparking tools, scoop spilled material into appropriate disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to control airborne concentrations. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry area away from all possible ignition sources and incompatibilities (Sec. 5), especially liquid acids. Protect containers against physical damage. Store in glass bottles, cans, and steel drums.

Engineering Controls: Avoid direct contact with skin and tissue. Do not handle with bare hands! Practice good personal hygiene. Do not expose sodium sulfide to any heat or ignition sources. Do not allow sodium sulfide to contact acids since their reaction evolves toxic hydrogen sulfide.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Sodium sulfide, anhydrous, or Sodium sulfide with less than 30% water of crystallization

DOT Hazard Class: Flammable solid

ID No.: UN1385

DOT Label: Flammable solid

DOT Packaging Requirements: 173.207

DOT Packaging Exceptions: 173.153

IMO Shipping Name: Sodium sulphide, anhydrous, or Sodium sulphide with less than 30% water of crystallization

IMO Hazard Class: 4.2

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

ID No.: UN1385

MSDS Collection References: 7, 73, 84, 85, 103, 123, 124, 126, 127, 136

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

 * M S D S *
 *
 * Canadian Centre for Occupational Health and Safety *

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 691711
 PRODUCT NAME(S) : ALCHEM 19
 SODIUM SULPHITE
 SODIUM SULFITE
 PRODUCT IDENTIFICATION : MSDS NUMBER: K1000146
 DATE OF MSDS : 1993-02-05

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
 ADDRESS : Post Office Box 2200
 Streetsville
 Mississauga Ontario
 Canada L5M 2H3
 Telephone: 800-387-2122 (Product Information)
 EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
 613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
 ADDRESS : Post Office Box 2200
 Streetsville
 Mississauga Ontario
 Canada L5M 2H3
 Telephone: 800-387-2122 (Product Information)
 EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
 613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

DuPont
 Material Safety Data Sheet

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KI000146 SODIUM SULFITE Printed 3-FEB-1994
 Revised 5-FEB-1993 -

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

Corporate MSDS Number : D0000171
CAS Number : 7757-83-7
Formula : Na2SO3
Molecular Weight : 126.04
CAS Name : SULFUROUS ACID, DISODIUM SALT

Tradenames and Synonyms

ALCHEM 19
SODIUM SULPHITE

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Canada, Inc.
P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS

Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
Sodium sulfite	7757-83-7	100

HAZARDS IDENTIFICATION

* Potential Health Effects

VENDOR HEALTH DATA

CAUTION: Contact with acids releases irritating and potentially fatal sulfur dioxide gas.

INHALATION

Inhalation of product dust or mist may irritate respiratory tract. Contact with acids liberates irritating and potentially fatal sulfur dioxide gas. May cause severe

KI000146

DuPont

Page 2

Material Safety Data Sheet

(HAZARDS IDENTIFICATION - Continued)

asthmatic response in sensitized individuals.

SKIN CONTACT

Dust or mist may cause skin irritation from prolonged contact. Solutions will irritate.

EYE CONTACT

Dust or mist may irritate or burn eyes. Solutions will irritate or burn.

INGESTION

Ingestion may irritate gastrointestinal tract by the liberation of sulfuric acid. Estimated to be moderately toxic. May cause severe allergic reaction in some asthmatics and sulfite sensitive individuals. Large doses may cause violent colic and diarrhea, circulatory disturbances, central nervous system depression and even death. Ingestion may include an asthmatic response if ingested minute quantities (10-100 mg) by sensitized individuals. Estimated fatal dose is 10 gm.

CONDITIONS AGGRAVATED BY EXPOSURE

Some individuals are said to be dangerously sensitive to minute amounts of sulfites in foods. Symptoms may include broncho constriction, shock, gastrointestinal disturbances, angio edema, flushing and tingling sensation. Circulatory disturbances and central nervous system (CNS) conditions may also be aggravated by exposure.

ANIMAL DATA

Oral ALD (rabbit): 2825 mg/kg

DU PONT HEALTH DATA

SODIUM SULFITE

HEALTH HAZARD INFORMATION:

Sodium sulfite is a skin, eye, nose and throat irritant. It can cause allergic skin rashes.

Inhalation can cause asthma-like reactions with shortness of breath, wheezing and cough.

Ingestion may cause gastric irritation, nausea, headache, weakness, dizziness, confusion, incoordination and loss of consciousness. Minute quantities in a sensitized person can cause an asthmatic response.

KI000146

DuPont
Material Safety Data Sheet

Page 3

(HAZARDS IDENTIFICATION - Continued)

Large doses of sulfite salts may cause violent colic, diarrhea, circulatory disturbances, central nervous system depression and death.

ANIMAL DATA:

Oral ALD: 2825 mg/kg in rabbits

HUMAN HEALTH EFFECTS OF OVEREXPOSURE:

Skin contact may initially include: skin irritation with discomfort or rash; or allergic skin rashes. The compound has been infrequently associated with skin sensitization in humans.

Eye contact may initially include: eye irritation with discomfort, tearing, or blurring of vision.

Inhalation may initially include: irritation of the upper respiratory passages, with coughing; or asthma-like reactions with shortness of breath, wheezing, or cough, and possibly occurring on subsequent reexposure.

Ingestion may initially include: nonspecific discomfort, such as nausea, headache, or weakness; temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness; or an asthmatic response if ingested in minute quantities (10-100 mg) by sensitized individuals.

Large doses of sulfite salts may cause violent colic and diarrhea, circulatory disturbances, central nervous system depression and death. Individuals with preexisting diseases of the lungs or skin may have increased susceptibility to the toxicity of excessive exposures.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

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Material Safety Data Sheet

(FIRST AID MEASURES - Continued)

In case of contact, immediately wash skin with soap and water. Wash contaminated clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, immediately give 2 glasses of water and induce vomiting. Never give anything by mouth to an unconscious person. Call a physician.

FIRE FIGHTING MEASURES

Flammable Properties

Not a fire or explosion hazard.

Hazardous gases/vapors produced in fire are oxides of sulfur.

Extinguishing Media

Use media appropriate for surrounding material.

Fire Fighting Instructions

Keep personnel removed and upwind of fire. Wear self-contained breathing apparatus. Wear full protective equipment. Cool tank/container with water spray.

Use water spray to knock down fumes.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Spill Clean Up

Recover undamaged and minimally contaminated material for reuse and reclamation. Shovel or sweep up.

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(ACCIDENTAL RELEASE MEASURES - Continued)

Accidental Release Measures

Dissolve in water, using caution as solution can get hot. Good ventilation is required during neutralization due to release of sulfur dioxide gas. Oxidation to sodium sulfite solution may be required, as for example, by adding a slight excess of dilute hydrogen peroxide carefully and with stirring.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe dust. Avoid contact with eyes, skin, or clothing. Wash thoroughly after handling. Wash clothing after use.

Handling (Physical Aspects)

Avoid dust generation.

Storage

Keep container in a cool place. Do not mix with incompatibles, as listed above. Store in a well ventilated place. Store in a cool place. Keep container tightly closed.

Store in a dry place. Keep away from acids, oxidizers, moisture. Protect from physical damage.

When dissolving, add water cautiously and with stirring.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Keep container tightly closed.

Keep container in a dry place.

Use ventilation that is adequate to keep employee exposure to airborne concentrations below exposure limits.

Contact with acids releases irritating and potentially fatal sulfur dioxide gas.

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Material Safety Data Sheet

(EXPOSURE CONTROLS/PERSONAL PROTECTION - Continued)

Personal Protective Equipment

EYE/FACE PROTECTION

Wear safety glasses. Wear coverall chemical splash goggles, and face shield when the possibility exists for eye or face contact from airborne material.

RESPIRATORS

A NIOSH/MESA approved air purifying respirator with a dust cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known,

or any other circumstances where air purifying respirators may not provide adequate protection.

PROTECTIVE CLOTHING

Wear impervious clothing to prevent ANY contact with this product, such as gloves, apron, boots, or whole bodysuit made from Neoprene, as appropriate.

Exposure Guidelines

Exposure Limits

SODIUM SULFITE

PEL (OSHA)	: Particulates (Not Otherwise Classified) 15 mg/m ³ , 8 Hr. TWA, total dust 5 mg/m ³ , 8 Hr. TWA, respirable dust
TLV (ACGIH)	: None Established

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point	: 900 C (1652 F) Decomposes
Melting Point	: Decomposes at red heat
Solubility in Water	: 13.9 gm/100 gm water @ 0 deg C (32 deg F)
pH	: 7.8 @ 1% solution
Odor	: Odorless
Form	: Fine crystals, granules, powder
Color	: White
Specific Gravity	: 2.633 @ 15C (60F)

Solubility in water : Calculated as the anhydrous salt
17% solution at 10 deg C (50 deg F)
28% solution at 33 deg C (91 deg F)

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STABILITY AND REACTIVITY

Chemical Stability

Stable at normal temperatures and storage conditions.

Reacts with oxidizing agents, such as chlorine, reducing agents, acids and bases. Can oxidize slowly in air to the sulfate.

Incompatibility with Other Materials

Incompatible with strong oxidizers, acids, high temperatures.

Decomposition

Decomposes with heat.

Hazardous gases/vapors produced are toxic and corrosive sulfur dioxide gas, sodium sulfide residue, sodium oxides. Decomposition temperature 1450 degC; decomposes by reaction with acids. Air and moisture sensitive.

Polymerization

Polymerization will not occur.

Other Hazards

Strong oxidizers cause vigorous exothermic reactions. Acids release sulfur dioxide gas.

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

96 hour LC50, goldfish: 100mg/L
24, 48, 96 hour TLM, mosquito fish: 2600 ppm

BOD 0.12 lb/lb instantaneous.

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DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do not flush to surface water or sanitary sewer system.

Neutralized waste may have to be disposed of by an approved contractor.

TRANSPORTATION INFORMATION

Shipping Information -- Canada

This material is Not Regulated.

REGULATORY INFORMATION

Canadian Regulations

CLASS D Division 2 Subdivision B - Toxic Material. Chronic Toxic Effects.

OTHER INFORMATION

NEPA, NPCA-HMIS

NPCA-HMIS Rating

Health : 2
Flammability : 0
Reactivity : 1

Personal Protection rating to be supplied by user depending on use conditions.

* Additional Information

Stanchem MSDS (1988 June 18)
Kingston Site MSDS
E.I. DuPont Textile Fibers Dept. MSDS (CD0555)

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : Environmental Affairs Group
Address : Kingston Site
P.O. Box 2100
DuPont

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(Continued)

Kingston, Ontario K7L 4Z6
Telephone : 613-544-6000

* Indicates updated section.

End of MSDS

* MSDS *
*
* Canadian Centre for Occupational Health and Safety *

*** IDENTIFICATION ***

DOD Hazardous Materials Information System
DoD 6050.5-L
AS OF May 1994

FSC: 1370
NIIN: 00N022490
Manufacturer's CAGE: 069K0
Part No. Indicator: A
Part Number/Trade Name: TRINITROTOLUENE WET

General Information

Item Name:
Manufacturer's Name: OCCUPATIONAL HEALTH SERVICES INC
Manufacturer's Street: 450 SEVENTH AVE SUITE 2407
Manufacturer's P. O. Box:
Manufacturer's City: NEW YORK
Manufacturer's State: NY
Manufacturer's Country: US
Manufacturer's Zip Code: 10123
Manufacturer's Emerg Ph #: 615-292-1180
Manufacturer's Info Ph #: 800-445-6737;212-967-1100
Distributor/Vendor # 1:
Distributor/Vendor # 1 Cage:
Distributor/Vendor # 2:
Distributor/Vendor # 2 Cage:
Distributor/Vendor # 3:
Distributor/Vendor # 3 Cage:
Distributor/Vendor # 4:
Distributor/Vendor # 4 Cage:
Safety Data Action Codes:
Safety Focal Points: N
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 28MAR90
Safety Data Review Date: 02JUN92
Supply Item Manager:
MSDS Preparer's Name:
Preparer's Company:
Preparer's St Or P. O. Box:
Preparer's City:
Preparer's State:
Preparer's Zip Code:
Other MSDS Numbers:
MSDS Serial Number: BNVGY
Specification Number:
Spec Type, Grade, Class:
Hazard Characteristic Code: NK
Unit Of Issue:
Unit Of Issue Container Qty:
Type Of Container:
Net Unit Weight:
NRC/State License Number:
Net Explosive Weight:
Net Propellant Weight-Ammo:
Coast Guard Ammunition Code:

=====

Ingredients/Identity Information

=====

Proprietary: NO
Ingredient: TOLUENE,2,4,6-TRINITRO-; (2,4,6-TRINITROTOLUENE) (TNT) (WET)
Ingredient Sequence Number: 01
Percent: <90
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: XU0180000
CAS Number: 118-96-7
OSHA PEL: S, 1.5 MG/M3
ACGIH TLV: S, 0.5 MG/M3; 9293
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: WATER
Ingredient Sequence Number: 02
Percent: >10
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: ZC0110000
CAS Number: 7732-18-5
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: SUPP DATA:REACTS W/IRON, SODIUM DICHROMATE, LEAD/OTHER HEAVY METALS/THEIR SALTS TO PRODUCE EXPLD SUBSTANCES. REACTS(ING 4)
Ingredient Sequence Number: 03
Percent: N/K
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: ING 3:REACTS VIGOROUSLY W/OTHER OXIDIZABLE MATERIALS.
Ingredient Sequence Number: 04
Percent: N/K
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: EFTS OF OVEREXP:SENSIT DERM IN PREVIOUSLY EXPSD PERS. ABSORP MAY BE INDICATED BY ORANGE STAINING ON EXPSD SKIN & (ING 6)
Ingredient Sequence Number: 05
Percent: N/K

Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: ING 5: COULD RESULT IN SYMPS LISTED IN INHAL. EYE: PARTICULATES
IN EYE MAY CAUSE IRRIT, REDNESS, PAIN, LACRIMATION (ING 7)
Ingredient Sequence Number: 06
Percent: N/K

Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: ING 6: & BLURRED VISION. INGEST: MAY CAUSE GASTRITIS, NAUSEA,
VOMITING, & SYMPTOMS LISTED IN INHALATION. CHRONIC: (ING 6)
Ingredient Sequence Number: 07
Percent: N/K

Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: ING 7: INHAL: PRLNGD/RPTD EXPOS MAY CAUSE PALLO, NAUSEA,
ANOREXIA, JAUNDICE, APLASTIC/HEMOLYTIC ANEMIA, OLIGURIA (ING 5)
Ingredient Sequence Number: 08
Percent: N/K

Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limit: N/K

Proprietary: NO
Ingredient: ING 8: OR ANURIA, ENLARGED LIVER, LIVER ATROPHY, CONVULS &
COMA. SKIN: PRLNGD/RPTD CNTCT MAY CAUSE SENSIT DERM: (ING 10)
Ingredient Sequence Number: 09
Percent: N/K

Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K

ACGIH TLV: N/K
Other Recommended Limits: N/K

Proprietary: NO
Ingredient: ING 9:OTHER EFTS MAY INCLUDE THOSE LISTED IN INHAL. EYE:
PRLNGD/RPTD CNTCT MAY CAUSE CATARACTS. THIS CLASS OF (ING 11)
Ingredient Sequence Number: 10
Percent: N/K
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limits: N/K

Proprietary: NO
Ingredient: ING 10:CHEM TYPICALLY CAUSES OPTIC NEURITIS, BLURRING OF
VISION/AMBYLOPIA, SOMETIMES FOLLOWED BY OPTIC ATROPHY. (ING 12)
Ingredient Sequence Number: 11
Percent: N/K
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limits: N/K

Proprietary: NO
Ingredient: ING 11:INGEST:PRLNGD/RPTD EXPOS MAY CAUSE SYMPS AS LISTED IN
INHAL.
Ingredient Sequence Number: 12
Percent: N/K
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limits: N/K

Proprietary: NO
Ingredient: FIRST AID PROC:LIFTING LIDS, UNTIL NO EVID OF CHEM REMAINS
(APPROX 15-20 MIN). GET MD IMMED. INGEST:REMOVE BY (ING 14)
Ingredient Sequence Number: 13
Percent: N/K
Ingredient Action Code:
Ingredient Focal Point: N
NIOSH (RTECS) Number: 9999999ZZ
CAS Number: N/K
OSHA PEL: N/K
ACGIH TLV: N/K
Other Recommended Limits: N/K

Proprietary: NO
Ingredient: ING 13:GASTRIC LAVAGE/EMESIS. MAINTAIN BLOOD PRESS & AIRWAY.

GIVE O*2 IF RESP. DEPRESSED. DO NOT PERFORM GASTRIC (ING 15)

Ingredient Sequence Number: 14

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

NIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 14: LAVAGE/EMESIS IF UNCONSCIOUS. GET MD IMMED. GASTRIC LAVAGE/O*2 GIVEN BY MD ONLY. ANTIDOTE: (ING 16)

Ingredient Sequence Number: 15

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

NIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 15: METHEMOGLOBINEMIA: (WHEN CONC OVER 25-40% IN PRESENCE OF SYMPS.) GIVE METHYLENE BLUE, 1% SOLN, (ING 17)

Ingredient Sequence Number: 16

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

NIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 16: 0.1 ML/KG IV OVER 10-MIN PERIOD. CYANOSIS MAY DISAPPEAR 2/IN MIN/PERSIST LONGER DEPENDING ON DEGREE OF (ING 18)

Ingredient Sequence Number: 17

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

NIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 17: METHEMOGLOBINEMIA. IV ADMIN OF THERAPEUTIC DOSES OF METHYLENE BLUE MAY CAUSE RISE IN BLOOD PRESS, NAUSEA (ING 19)

Ingredient Sequence Number: 18

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

DIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 18:8. DIZZ. LARGER DOSES (2500 MG) CAUSES VOMIT, DIARRHEA, CHEST PAIN, MENTAL CONFUSN, CYANOSIS & SWEATING. (ING 20)

Ingredient Sequence Number: 19

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

DIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 19:HEMOLYTIC ANEMIA HAS ALSO OCCURRED SEVERAL DAYS AFTER ADMIN. THESE EFTS TEMPORARY & FATALITIES HAVE NOT (ING 21)

Ingredient Sequence Number: 20

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

DIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 20:BEEN REPORTED. IF METHYLENE BLUE NOT AVAIL, GIVE ASCORBIC ACID, 1 GRAM SLOWLY, IV. W/OUT TREATMENT, (ING 22)

Ingredient Sequence Number: 21

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

DIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Proprietary: NO

Ingredient: ING 21:METHEMOGLOBINEMIA LEVELS OF 20-30% REVERT TO NORMAL W/ IN 3 DAYS.

Ingredient Sequence Number: 22

Percent: N/K

Ingredient Action Code:

Ingredient Focal Point: N

DIOSH (RTECS) Number: 9999999ZZ

CAS Number: N/K

OSHA PEL: N/K

ACGIH TLV: N/K

Other Recommended Limit: N/K

Physical/Chemical Characteristics

Appearance And Odor: YELLOW CRYSTALLINE SLUDGE OR SLURRY.

Boiling Point: EXPLODES

Melting Point: 176F, 80C

Vapor Pressure (MM Hg/70 F): 0.042 @80C

Vapor Density (Air=1): N/K

Specific Gravity: 1.7

Decomposition Temperature: N/K

Evaporation Rate And Ref: N/K

Solubility In Water: 0.01% @ 25C

Percent Volatiles By Volume: N/K

Viscosity:

pH: N/K

Radioactivity:

Form (Radioactive Matl):

Magnetism (Milligauss):

Corrosion Rate (IPY): N/K

Autoignition Temperature:

Fire and Explosion Hazard Data

Flash Point: FLAMMABLE SOLID

Flash Point Method: N/K

Lower Explosive Limit: N/K

Upper Explosive Limit: N/K

Extinguishing Media: FLOOD W/WATER, IF NO WATER AVAILABLE USE DRY CHEMICAL OR DIRT. LG FIRES: W/DRAW FROM AREA & LET FIRE BURN.

Special Fire Fighting Proc: WEAR NIOSH/MSHA APPROVD SCBA & FULL PROT EQUIP (PP N). DO NOT MOVE CARGO/CNTNR IF EXPOS TO HEAT OCCURRED. FOR MASSIVE FIRE IN STOR AREA, USE UNMANNED (SUPP DATA)

Usual Fire And Expl Hazrds: DANGEROUS FIRE & EXPLO HAZ WHEN EXPSD TO HEAT. FLAME/SHOCK WHEN ALLOWED TO DRY. WET, IGNITES W/DIFFICULTY BUT WILL BURN. FINELY DISPERSED SOLIDS ARE EXPLOSIVE.

Reactivity Data

Stability: YES

Cond To Avoid (Stability): MATL EXPLOSIVE WHEN DRY. AVOID CONTACT W/ALL SOURCES OF IGNITION. AVOID OVERHEATING & SHOCK.

Materials To Avoid: MAY EXPLODE ON CNCT W/NITRIC/SULFURIC ACID. HEATING /ALKALIES/AMMONIA MAY CAUSE VIOLENT EXPLO. REACTION (SUPP DATA)

Hazardous Decomp Products: THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC COXX & NOXX.

Hazardous Poly Occur: NO

Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

LD50-LC50 Mixture: LD50:(ORAL,RAT)795 MG/KG.

Route Of Entry - Inhalation: YES

Route Of Entry - Skin: YES

Route Of Entry - Ingestion: YES

Health Haz Acute And Chronic: SKIN, EYE & MUC MEMB IRRITANT; SKIN

SENSITIZER, NEUROTOXIN, HEPATOTOXIN, NEPHROTOXIN, & BONE MARROW DEPRESSANT.

ACUTE: INHAL: UNLIKELY BUT MAY CAUSE NOSE & THROAT IRRIT, SNEEZING, COUGHING,

CHEST SCRAPNESS, DYSPNEA, VOMIT & DIARRHEA. SYSTEMIC EFFECTS MAY INCLUDE HOBCH, DIZZ, PALLOR, HYPOTENSION, LETHARGY, (EFFECTS OF OVEREXP)

Carcinogenicity - NTP: NO

Carcinogenicity - IARC: NO

Carcinogenicity - OSHA: NO

Explanation Carcinogenicity: NOT RELEVANT

Signs/Symptoms Of Overexp: HLTH HAZ:CONFUSN, JAUNDICE, PERIPHERAL NEUROPATHY, OLIGURIA, ANURIA, TOX NEPHRITIS, APLASTIC ANEMIA, HEMOLYTIC ANEMIA, CONVULSN & DEATH. CYANOSIS MAY INDICATE METHENOGLOBIN FORMATION. DEATHS HAVE BEEN REPORTED FROM TOXIC HEPATITIS, APLASTIC ANEMIA/BOTH. SKIN: MAY CAUSE IRRIT, ERYTHEMA, PAPULES, SEVERE ECZEMA & (ING 5)

Med Cond Aggravated By Exp: PERSONS W/GLUCOSE-6-PHOSPHATE DEHYDROGENASE DEFICIENCY MAY BE AT INCREASED RISK FROM EXPOSURE.

Emergency/First Aid Proc: INHAL:REMOVE TO FRESH AIR IMMED. IF BRTHG STOPPED GIVE ARTF RESP. MAINTAIN AIRWAY & BLOOD PRESS & GIVE O₂. KEEP WARM & AT REST. TREAT SYMPTOMATICALLY & SUPPORTIVELY. GET MD IMMED. SKIN:REMOVE CONTAMD CLTHG & SHOES IMMED. WASH W/SOAP/MILD DETERGENT & LG AMTS OF WATER UNTIL NO EVID OF CHEM REMAINS (APPROX 15-20 MIN). GET MD IMMED. EYE:WASH IMMED W/LG AMTS OF WATER/NORM SALINE OCCASMLY (ING 13)

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: SHUT OFF IGNIT SOURCES. DO NOT TOUCH SPILLED MATL. EPL:FLUSH AREA W/FLOODING AMTS OF WATER. LG:WET DOWN W/WATER & DIKE FOR LATER DISPOSAL. NO SMOKING, FLAMES/FLARES IN HAZARD AREA. KEEP UNNECESSARY PEOPLE AWAY. ISOLATE HAZARD AREA & DENY ENTRY.

Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.

Waste Disposal Method: DISPOSE OF I/A/W FEDERAL, STATE AND LOCAL REGULATIONS (FP N).

Precautions-Handling/Storing: STORE ONLY IN PERMANENT MAGAZINE.

Other Precautions: THIS HIGH EXPLOSIVE SHOULD BE KEPT WELL AWAY FROM INITIATOR EXPLOSIVES; PROTECTED FROM PHYSICAL DAMAGE, SEPARATED FROM OXIDIZING MATERIALS, COMBUSTIBLES & SOURCES OF HEAT.

Control Measures

Respiratory Protection: ALL RESP MUST BE NIOSH/MSHA APPRVD: 5 MG/M³: SUPPLIED AIR RESP/SCBA, 25 MG/M³: SUPPLIED AIR RESP/SCBA W/FULL FACEPIECE, 1000 MG/M³: SUPPLIED AIR RESP/SCBA W/FULL FACEPIECE OPERATED IN PRESS-DEMAND/OTHER POS PRESS MODE.

Ventilation: PROVIDE LOCAL EXHAUST VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS. VENT EQUIPMENT MUST BE EXPLOSION-PROOF.

Protective Gloves: IMPERVIOUS GLOVES (FP N).

Eye Protection: CHEM WORK GOG & FULL LENGTH FSHLD(FP N).

Other Protective Equipment: IMPERVIOUS CLTHG,EQUIP TO PVNT SKIN CNTCT. PROVIDE EYE WASH FOUNTAIN-QUICK DRENCH SHOWER W/IN IMMED WORK AREA FOR EMER.

Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER.

Suppl. Safety & Health Data: FIRE FIGHT PROC:HOSE HOLDER/MONITOR NOZZ; ELSE W/DRAW FROM AREA & LET BURN. DANGEROUSLY EXPLOSIVE! FLOOD W/WATER. COOL CNTNRS W/FLOODING AMTS. APPLY FROM AS FAR A DISTANCE AS POSS. EVAC TO RADIUS OF 5000 FT FOR UNCONTROLLABLE FIRES. MATLS TO AVOID:W/POTASSIUM HYDROXIDE IN METHANOL PRDCE EXPLO ACI-NITRO SALTS. (ING 3)

* CHEMINFO *
*
* Canadian Centre for Occupational Health and Safety *

*** SECTION 1. CHEMICAL IDENTIFICATION ***

CHEMINFO RECORD NUMBER : 2022
CCOHS CHEMICAL NAME : 2,4,6-Trinitrotoluene
SYNONYMS :
* 1-Methyl-2,4,6-Trinitrobenzene
* alpha-TNT
* s-Trinitrotoluene
* s-Trinitrotoluol
* sym-Trinitrotoluene
* TNT
* Trinitrotoluene
CAS REGISTRY NUMBER : 118-96-7
PIN (UN/NA NUMBER(S)) : 1356 0209
RTECS NUMBER(S) : XU0175000
MOLECULAR FORMULA : C7-H5-N3-O6

STATUS :

This CHEMINFO record is not complete and only contains readily available information at this time.

Information on chemicals reviewed in the CHEMINFO database is drawn from a number of publicly available sources. A list of general references used to compile CHEMINFO records is available in the database Help.

*** SECTION 2. DESCRIPTION ***

APPEARANCE AND ODOUR :
Yellow solid

*** SECTION 5. FIRE FIGHTING MEASURES ***

FLASH POINT :
Explodes

*** EXPOSURE GUIDELINES ***

* THRESHOLD LIMIT VALUES (TLVs) / AMERICAN CONFERENCE OF
GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH) / 1993-94 *

TIME-WEIGHTED AVERAGE (TLV-TWA) : 0.5 mg/m3 - skin
TLV COMMENTS :

"SKIN" NOTATION: Contact with skin, eyes, and mucous membranes can contribute to the overall exposure and may invalidate the TLV. Consider measures to prevent absorption by these routes.

NOTE: In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. Since the manner in which exposure limits are established, interpreted, and implemented can vary, obtain detailed information from the

appropriate government agency in each jurisdiction.

* PERMISSIBLE EXPOSURE LIMITS (PELs) /
FINAL RULE LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 0.5 mg/m3

FINAL RULE LIMIT PEL COMMENTS :

"SKIN" DESIGNATION: Skin contact can contribute to the overall exposure to this chemical. Prevent or reduce skin absorption through the use of gloves, coveralls, goggles or other appropriate personal protective equipment, engineering controls or work practices.

NOTE: The OSHA PEL Final Rule Limits are currently non-enforceable due to a court decision. The OSHA PEL Transitional Limits are now in force.

* PERMISSIBLE EXPOSURE LIMITS (PELs)
TRANSITIONAL LIMITS / OCCUPATIONAL
SAFETY AND HEALTH ADMINISTRATION (OSHA) *

TIME WEIGHTED AVERAGE (PEL-TWA) : 1.5 mg/m3

TRANSITIONAL LIMIT PEL COMMENTS :

"SKIN" DESIGNATION: Skin contact can contribute to the overall exposure to this chemical. Prevent or reduce skin absorption through the use of gloves, coveralls, goggles or other appropriate personal protective equipment, engineering controls or work practices.

*** SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ***

MOLECULAR WEIGHT : 227.13
MELTING POINT : 80.7 deg C
BOILING POINT : explodes @ 240 deg C
RELATIVE DENSITY (SPECIFIC GRAVITY) :
1.654 @ 20 deg C (water = 1)
SOLUBILITY IN WATER :
0.013%
VAPOUR DENSITY : 7.85 (air = 1)
VAPOUR PRESSURE : 0.05 mm Hg @ 85 deg C

*** SECTION 12. ECOLOGICAL INFORMATION ***

NOTE : This section is under development.

*** SECTION 15. REGULATORY INFORMATION ***

** WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) **

WHMIS INGREDIENT DISCLOSURE LIST :

Included for disclosure at 1% or greater

REVIEW/PREPARATION DATE :

1986-07-23

REVISION INDICATORS :

PEL-TWA; 1993-04

PEL comments; 1993-04

Trans PEL-TWA; 1993-04

Trans PEL comments; 1993-04



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Material Safety Data Sheets Collection:

Sheet No. 73
Zinc Metal/Powder

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Section 1. Material Identification

Zinc Metal/Powder Description: A metallic element extracted from ores which are first roasted to form zinc oxide and then: 1) the zinc oxide is leached from the roasted material with sulfuric acid to form a zinc sulfate solution which is electrolyzed in cells to deposit zinc on cathodes and 2) the zinc oxide is reduced with carbon in retorts (distilling vessels) to yield distilled and condensed zinc. Used as ingredient in alloys such as brass, bronze, and die-casting alloys; galvanizing sheet iron; for electrical apparatus, especially castings, building materials, dry cell batteries, automotive equipment, household utensils, railroad car linings; as a fungicide; in nutrition (essential growth element); as reagent in analytical chemistry; in bleaching bone glue, manufacturing sodium hydrosulfite, and insulin zinc salts.

Other Designations: Blue powder; spelter; granular zinc; jasad; merrillite; pasco; Zn; CAS No. 7440-66-6.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 1
S 1
K 1

NFP

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H
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PPG
* Sec

Section 2. Ingredients and Occupational Exposure Limits

Zinc metal/powder, ca 99%

OSHA PEL
None established*

ACGIH TLV, 1989-90
None established*

NIOSH REL, 1987
None established*

Toxicity Data†
Human, inhalation, TC_{Lo} : 124 mg/m³/50 min,
pulmonary system effects

* The current OSHA standard and ACGIH (1989-1990) TWA for zinc oxide (ZnO) fumes is 5 mg/m³. The ACGIH TWA for zinc oxide dust is 10 mg/m³, provided that total contains no asbestos and is <1% crystalline silica. NIOSH has recommended a 10-hr TWA of 5 mg/m³ and a ceiling level of 15 mg/m³ (15-min sample) for zinc oxide fume. The TLV-TWA level was set to prevent metal fume fever.

† See NIOSH, *RTECS* (ZG8600000), for additional data with references to irritative effects.

Section 3. Physical Data

Boiling Point: 907 °F (1663 °C)

Melting Point: 419 °F (787 °C)

Vapor Pressure: 1 mm Hg at 909 °F (487 °C)

Brinell Hardness: 31

Atomic Weight: 65.37 g/mol

Specific Gravity ($H_2O = 1$ at 39 °F (4 °C)): 7.13 at 77 °F (25 °C)

Water Solubility: Insoluble

Index of Explosibility, Zn Powder (<0.1 weak, >10 severe): 0.1

Appearance and Odor: Bluish-white lustrous metal, also finely divided forms.

Section 4. Fire and Explosion Data

Flash Point: None reported Autoignition Temperature: Cloud, 1256 °F (680 °C);* dust layer, 860 °F (460 °C);* powder, 650 mJ* LEL: Dust cloud explosion, 0.5 oz/ft³ UEL: None reported

Extinguishing Media: Use special dry chemical or clean dry sand. *Never* use CO₂. Using a direct stream of water may scatter the fire or disperse dust, creating a potentially explosive mixture if exposed to heat or ignition sources. A water spray may be used to cool fire-exposed containers and disperse vapors.

Unusual Fire or Explosion Hazards: Flammable hydrogen gas is liberated by reaction with alkali hydroxides (sodium, potassium, and calcium hydroxides), acids, or even water (when material is in dust form) and is an explosion hazard in a confined space. In a fire, zinc may melt, vaporize, and burn to form ZnO fumes (Sec. 2).

Special Fire-fighting Procedures: For major fires, or if large quantities of this material are involved, fire fighters should wear appropriate protective clothing and respiratory protection. Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Zinc dust refers to the product of zinc vapor condensation, and zinc powder to the product of molten zinc atomization (*Zinc Dust and Zinc Powder: Their Production, Properties, and Applications*, B.C. Hafford, W.E. Pepper, and T.B. Lloyd, 1982). Dust 100% thru 74-µm sieve; a 0.96-J spark can ignite a cloud. The ignition temperature in CO₂ is 896 °F (480 °C). The reaction temperature in a nitrogen atmosphere is 1112 °F (600 °C).

Stability/Polymerization: Zinc is stable in dry air at room temperature. Moist zinc dust can react exothermically and ignite spontaneously in air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Zinc dust is an explosion hazard when reacted with acids, chlorates, oxidizing agents (sulfur and oxygen), halogenated hydrocarbons, hydrazine mononitrate, hydroxylamine, ammonium nitrate, barium dioxide, barium nitrate, cadmium, performic acid, manganese chloride, nitric acid, ethyl acetoacetate and tribromoneopentyl alcohol, tellurium, carbon disulfide, lead azide, magnesium and barium nitrate and barium dioxide, selenium, sodium peroxide, potassium nitrate, and water. In humans, a toxic effect results from inhaling 124 mg/m³ zinc metal/powder for 50 min.

Hazardous Products of Decomposition: Thermal oxidative decomposition of zinc can produce highly toxic fumes. Above 999 °F (537 °C) vaporized zinc burns in air with a blue-green flame to produce zinc oxide fumes.

Section 6: Health Hazard Data

Cardiogenicity: Neither the NTP, IARC, nor OSHA lists zinc as a carcinogen.

Summary of Risks: Zinc is relatively nontoxic, but when combined with other materials such as oxygen or mineral acids, the resulting compounds can have toxic effects. It is not readily absorbed through the skin, gastrointestinal (GI) tract, or lungs. Although most inorganic zinc compounds are potential causes of gastroenteric irritation, a high-level dose is relatively nontoxic when ingested. Zinc is considered essential to life. Ingestion of soluble salts may cause nausea and vomiting, sluggishness, and light-headedness. Inhalation of zinc fumes normally generated by zinc and extreme heat may cause *metal fume fever*, which is accompanied by throat dryness and irritation, coughing, weakness, dyspnea, and generalized aching that generally passes within 24 hr. These symptoms usually begin 3 to 10 hr after exposure and resolve within 24 to 48 hr. Inhalation of zinc dust may cause mild irritation to the upper respiratory tract. Prolonged skin contact with zinc may cause a mild, drying dermatitis.

Medical Conditions Aggravated by Long-Term Exposure: Since metallic zinc particulates can be considered a nuisance dust, repeated inhalation of zinc dust could lead to respiratory complications.

Target Organs: Respiratory system.

Primary Entry: Inhalation, ingestion.

Acute Effects: Metal fume fever is an acute, self-limiting condition, without recognized complications, aftereffects, or chronic forms. Symptoms appear several hours after exposure. Removal from exposure normally alleviates symptoms with no residual or chronic effects. A degree of tolerance may result from continued exposure, but is quickly lost after a day or two of nonexposure.

Chronic Effects: Zinc and zinc powder have little history of causing chronic effects.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. **Physician's Note:** Calcium disodium edetate (CaNa₂-EDTA) has been used medically to increase the rate of zinc removal from the body; however, this usually results from chronic fume exposure or exposure to zinc salts, not to zinc metal powders.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7: Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of powder spills. Eliminate all heat and ignition sources. Cleanup personnel should protect against dust inhalation and eye contact. Use nonsparking tools for cleanup. Sweep or otherwise place the spilled material in an appropriate, pressure-vented, dry-metal container (with lid) for later disposal. Container should be pressure vented. Avoid creating airborne dust conditions.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Zinc (fume or dust) is listed as SARA Toxic Chemical (40 CFR 372.65)

Section 8: Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: For zinc oxide dust or fume concentrations up to 50 mg/m³ and 250 mg/m³, use, respectively, a fume (high-efficiency particulate) respirator or an air-supplied or self-contained respirator with a full facepiece. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below established TLVs-TWAs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. Wash thoroughly before changing to street clothes.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9: Special Precautions and Comments

Storage Requirements: Store in covered metal containers in a dry, well-ventilated, low fire risk area. Protect containers from physical damage. Never store with acids, halogenated hydrocarbons, or strong alkalis.

Engineering Controls: Avoid breathing dust or fumes. Use good housekeeping and cleaning techniques to minimize airborne particulates and to prevent dust accumulation. Provide suitable training in personal hygiene and in the cause and effect of metal fume fever. Prevent exposure of workers with respiratory problems or gastrointestinal disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Zinc, powder or dust, nonpyrophoric

IMO Shipping Name: Zinc, powder or dust, pyrophoric

IMO Hazard Class: 4.3

IMO Hazard Class: 4.2

IMO Label: Dangerous when wet

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

IMDG Packaging Group: II

MSDS Collection References: 2, 4-11, 24, 31, 39-41, 80, 81, 84, 85, 91, 109

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